MODEL AIRPLANE NEWS

SCALE HYDRAULIC BRAKES

THE WORLD'S PREMIER R/C MODELING MAGAZINE

48120

July 1995

MASTER CROSS-WIND FLIGHT

BIGGEST R/C TIGERCAT! PAGE 138

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JULY 1995 VOLUME 123, NUMBER 7

MODEL AIRPLANE NEWS

FEATURES

ABOVE: *powered by two Russian Angstrem .91s, Wolfgang Klühr's impressive MiG 29 executes an effortless climb-out after takeoff. See our feature, "Jets Over Deland," by Dan Parsons for details. (Photo by Dan Parsons.)*

ON THE COVER: *main photo—Thunder Tiger USA's new .40-size Tiger Trainer offers a quick and easy way to get into the air. Wooden ARFs are the latest things in "almost-instant" model aviation. Inset: Jet Hangar Hobbies F-86 Sabre Jet and our featured "construction" airplane, the Webra 1.20-powered Huskie aerobatic bipe.*

FEATURES

CONSTRUCTION

COLUMNS

COLUMNS

DEPARTMENTS

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EDITORIAL

TOM ATWOOD

AIR SHOW INFO AND A FAREWELL

If you've stood on the edge of a flight line and watched a full-scale aerobatic airplane perform a snap roll just after takeoff, then you know how riveting full-scale air shows can be. Such shows are aviation spectacles that stir the heart and inspire the modeler in us all. Some of the top air shows feature famous show teams such as the Blue Angels and often include exhibits or flybys by WW II "heavy iron." Other shows feature comic, seemingly death-defying routines by barnstormers flying such aircraft as Cubs and Taylorcraft. Air shows are low-cost, high-quality family outings, so there are benefits for more than just the modeler in the family.

USA AIRSHOW HOTLINE

Identifying the location and date of the next air show in a given state has become easier with the recent introduction of a new air-show 900 number: the USA AIRSHOW HOTLINE, which is run by Astradyne Inc.—a company that has no connection to *Model Airplane News*. Selections are menu-driven by state and date ($1.99/minute). You can find out about all the air shows, fly-ins and aerobatic competitions as well as the 1995 schedules for the Blue Angels, Thunderbirds, Sean Tucker, the Snowbirds, the Eagle Aerobatic Team and dozens of other teams and performers. The number—1-900-287-1000—is operational 24 hours a day in all 50 states.

SURVEY

Many of our readers will soon receive a Reader Survey form in their next issue of *Model Airplane News*. If you receive one and would like to help us produce a better magazine, please fill out and return the survey. You'll be helping us serve our entire readership.

A GREAT ACHIEVER

We were saddened to learn of the passing of Irwin S. Polk—one of the founding fathers of a hobby that has now become a sport of global proportions. We thank David M. Daniels for his tribute to Mr. Polk, who played such a pivotal role in this industry. We extend our heartfelt condolences to the Polk family. ■

A Modeling Giant Who Walked Among Us...

Irwin S. Polk

1912-1995

How can we, in a single article, sum up the achievements and triumphs of a man who, with his brother Nathan, came to America and not only changed the face of the hobby world but, in many ways, also helped to create it?

One of the founders of the Junior Birdmen of America—a model club backed by the powerful Hearst newspaper chain—Irwin Polk wrote articles on modeling; his column, which was devoted exclusively to the hobby, appeared in 17 cities nationwide. He organized the 1932 Depression Nationals in Atlantic City as well as the first all-gas-model meet in Caldwell, NJ, in 1935.

Irwin and his wife, Chuddy, convinced the retailing magnate Louis Bamberger to make provisions for an entire hobby department at his Newark store. Out of this grew the 5,000-member Bamberger Auto Club, which brought many of us into the hobby. Modelers heard Saturday morning guest speakers such as Amelia Earhart, Jimmy Doolittle, Admiral Byrd, Sir Hubert Wilkins, Col. Roscoe Turner and other luminaries.

In 1935, Irwin and Nathan founded Polk's Modelcraft Hobbies and Polk Brothers Hobby Distributors on 7th Avenue in New York City—three floors overflowing with planes, boats, racecars and trains. This, remember, was before there was such a thing as a "hobby shop"!

Irwin and Nathan are deservedly members of the AMA Hall of Fame. After all, it was they who prodded the then National Aeronautics Administration to give its imprimatur to the organization of which most of us are now members. The insurance program was also largely their inspiration.

They unselfishly brought their genius for business and modeling to us all, and they may well have been responsible for inspiring (as well as serving) the burgeoning interest in modeling that preceded WW II. Their 60-year record is a testament to the veracity of that argument. Many brand names—Ideal, Guillow, Comet, Megow, Burd, Hiller, Comet and many others, along with the Mighty Atom engine (the .099 miracle that was at least 15 years ahead of its time and was my first engine), the Aristo Craft, the Constructo and the Mabuchi motors—became a reality through the vision of Irwin and Nathan.

To properly assess the contributions that Irwin S. Polk made to modeling would require several books. Would any of us have had the courage to persist in the face of the Depression with the wisdom and drive of this great man and his brother? They even tested early kits and obtained the "Good Housekeeping Seal of Approval" to prove their integrity to the then-mighty magazine before distributing them.

Irwin conceived the concept of rewarding neophyte model builders for building and flying their first "ROG"; the reward was a bar for their Bamberger Aero Club pin. He and Nathan directed the 1932 and the 1936 through 1939 National Championship Air Model Meets, the International Lord Wakefield Competition (1941) plus all the early model meets in the Eastern states. They also laid the groundwork for the Model Hobby Trade Association and introduced "Jetex" and tabletop electric car racing to America.

As the line from Arthur Miller's greatest play reads, "Attention must be paid to this man!" Let *us* pay attention to Irwin S. Polk. We owe him that...and a lot more!

—David M. Daniels

MODEL AIRPLANE NEWS

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AIRWAVES

WRITE TO US! We welcome your comments and suggestions. Letters should be addressed to "Airwaves," **Model Airplane News,** 251 Danbury Road, Wilton, CT 06897. Letters may be edited for clarity and brevity. We regret that, owing to the tremendous numbers of letters we receive, we cannot respond to every one.

MODELS NEEDED

The Bruce Museum of Greenwich, CT, is putting together two exhibits on flight and would like to use models to show what various full-size planes looked like. The following items are needed by August 1995 and will be exhibited from February 1996 through June 1996.

- Large, 4- to 6-foot-long models of the Wright Flyer or other very early planes, e.g., the Bleriot; famous WW I planes such as the Red Baron's Fokker triplane and Lindbergh's Spirit of St. Louis; and modern sport planes and gliders such as an ultralight.
- Medium-size R/C helicopters and planes; a small, scale, working wind tunnel or another device for testing airfoils and demonstrating their role in guiding/stabilizing.
- Large uncovered wing of a model plane showing its structure (struts, etc.); helicopter rotor blade.
- Smaller planes and gliders, such as the Lilienthal, an ornithopter, an Airial steam carriage, Wright Flyer or Bleriot's plane; an early helicopter, such as Cornu's 1907 heli; Spirit of St. Louis; Amy Johnson's Gypsy Moth (1930); Jenny; famous WW I planes such as the Sopwith Camel, SPAD; Red Baron's Fokker triplane; Harriet Quimby's aerobatic plane or another barnstormer; first airmail-service plane; first passenger-service plane; famous WW II planes such as the Spitfire and Mustang; post WW-II military planes; commercial jet liners; Bell X; Blackbird (spy plane); one of Amelia Earhart's planes; Harrier VTOL; commercial or military helicopter; sea plane; contemporary aerobatic plane; Gossamer Condor or Albatross.

If you have questions, or would like to send a model to the museum, please contact Lisette Henrey, Associate Curator of Education, 1 Museum Dr., Greenwich, CT 06830-7100; (203) 869-0376. Your models will be returned as soon as the exhibit ends.

WHAT'S THE SCOOP?

In the April '95 issue, Chris Chianelli reported on the F-82 Twin Mustang from EZ OK Model Co. I'm very interested in it, and I've tried to contact the company, but haven't had any luck. Can you please give me their address?

TONY PALANZO
Anaheim, CA

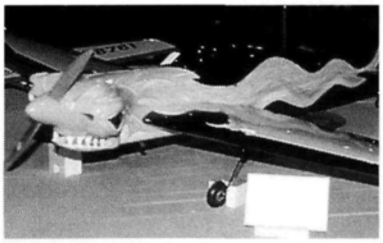
Tony, the EZ OK Model Co. is in the process of changing its U.S. distributor. As soon as we find out who their new distributor will be, we'll let you know. GY

LOOKIN' FOR A LONG EZ

Where can I get a Long EZ design kit, which was formerly offered by Cressline? The hobby is alive and well in Jakarta. Many of the locals are accomplished fliers and builders. Thanks for a great magazine; keep up the good work.

JON AND BARBARA GAYNOR
Jakarta, Indonesia

The 1/5-scale Cressline Long EZ kit is now available from Flightech Models Inc., 1441 N. Mayfair Rd., Milwaukee, WI 53226; (414) 257-1923. This sport-scale model of Burt Rutan's all-composite canard has a wingspan of 62 inches and is designed for .40 to .45 engines. Flightech also offers other Cressline models, including the 1/4-scale Quickie. Give them a call, and tell them "Model Airplane News" sent ya. GY



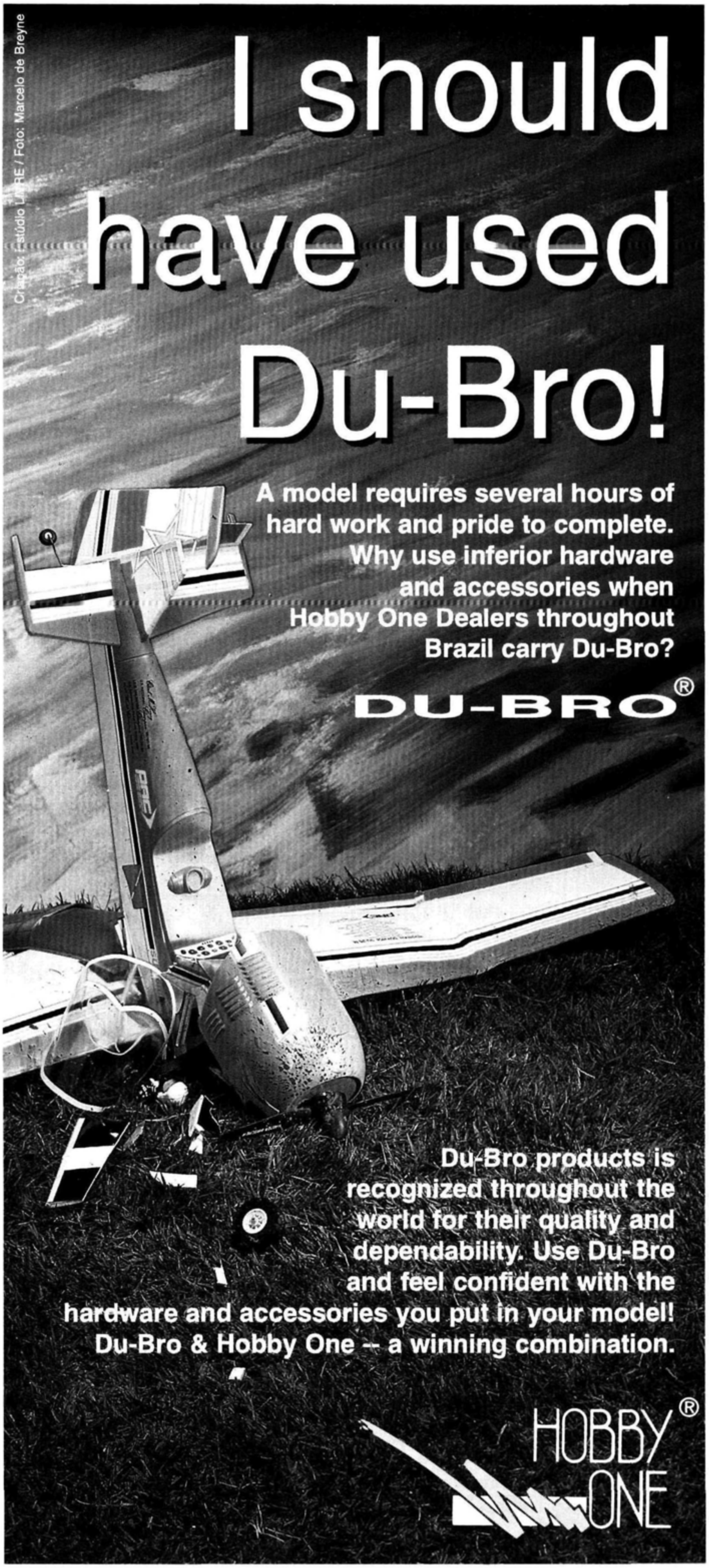
MONOKOTE NOTES

I've seen many models covered with MonoKote and other iron-on, plastic

coverings. I know trim stripes that can be ironed *over* the original covering are available, but this seems like needless additional weight to me, especially with complex, multicolored schemes. I've thought of doing a sunburst pattern on the wing of a Citabria, but I don't want to use MonoKote trim stripes. I want to cut white and red triangles to make up the pattern and allow 1/4 inch overlap. Next, I'll stick the white triangles to glass with water. Finally, I'll cut back the backing of the red covering, and I'll melt the adhesive with a special solvent and stick the red triangles to the white triangles. I'll end up with a piece that's ready to use and has a double thickness only at the overlap. Is this idea feasible?

HOWARD SULLIVAN
Huntsville, AL

Howard, this idea is very feasible; in fact, author and covering ace Faye Stilley writes about the same process in his books, "Covering R/C Airplanes," Volumes 1 and 2. Using the special solvent to join multicolored panels without heat is just one of his many covering secrets. At April's Weak Signal's R/C Hobby Show in Toledo, OH, Faye won second place in "MonoKote" for one of his finishes. His model was a pattern ship with an unusual carved-balsa dragon's head for an engine cowl. The teeth, lips and tongue were all carved out and individually MonoKoted! The wing and fuselage were decorated in a realistic dragon motif. He did this using the solvent technique. So why reinvent the wheel? Check out Faye's methods; call the Air Age Publishing order line—(800) 243-6685. Faye can also be reached by calling the Model Airplane News plans information line—(203) 762-1079. Good luck! GY ■



AEROBATICS MADE EASY

DAVE PATRICK

CROSSWIND FLYING

ONE OF THE most popular questions I am asked is how to fly in a crosswind. Many pilots get intimidated when the wind is not straight down the runway, which is understandable. Although it's a bit difficult to fly in a crosswind, anyone can learn to do it well. It just takes a little understanding, some practice and forethought. While having this skill is imperative in competition, it's also very helpful to the beginner/sport flier. I strongly recommend that all pilots try to understand crosswind effects and how to compensate. I've already covered how to take off (July '92 "Aerobatics Made Easy") and land (August '92) in a crosswind, and how to handle a crosswind when performing a Humpty Bump (May '95), so in this column, let's get right to flying in a crosswind.

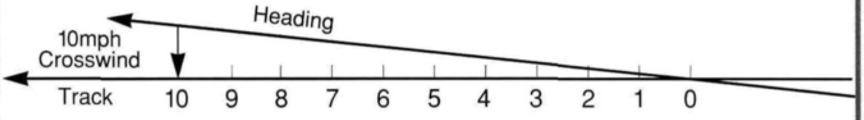
HEADING AND TRACK

There are two ways to fly an aircraft in a crosswind. One, which is really a constant process, involves compensating for the crosswind by adjusting the heading to get the desired track. Remember, "heading" is the direction in which the plane is pointed; "track" is the actual path in which the airplane flies. The other method is to fly the maneuvers straight and to intermittently compensate for crosswind-induced drift by flying a separate maneuver altogether. Interestingly enough, different types of competitions use different techniques, and using the wrong one can cost you big points!

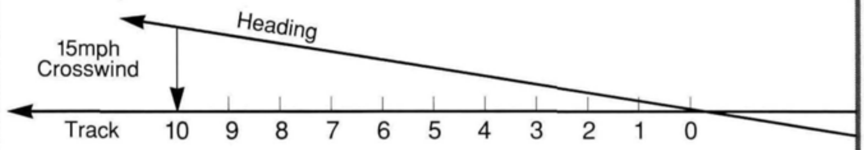
HOW MUCH ANGLE?

In most situations, I recommend using the technique in which you adjust the heading to establish proper track. Let's say you simply want to make a pass down the center line of the runway. The wind is blowing in your face at 10mph, your model air speed is at an

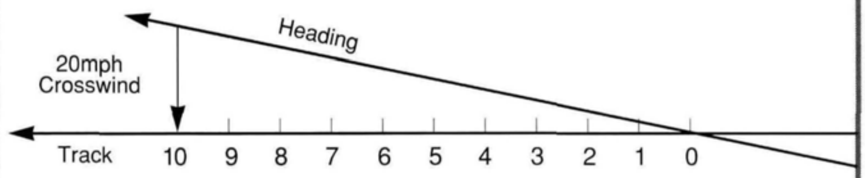
VECTOR DIAGRAMS



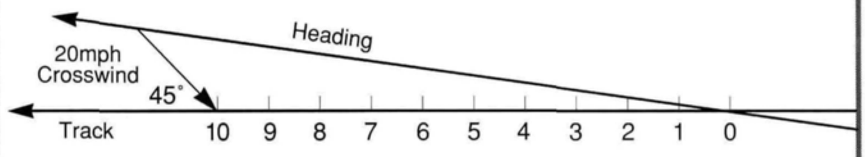
10mph Crosswind
FIGURE 1



15mph Crosswind
FIGURE 2



20mph Crosswind
FIGURE 3



20mph at 45°
FIGURE 4

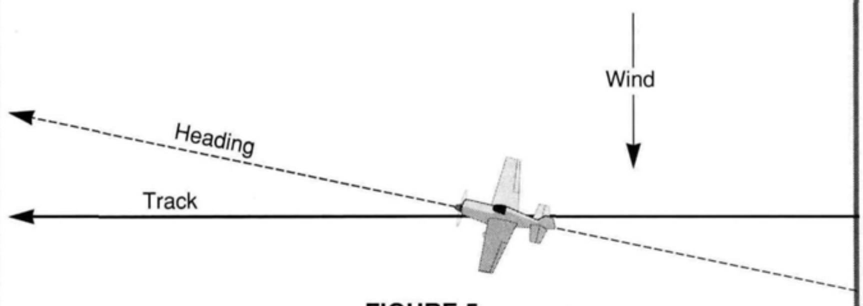


FIGURE 5

even 100mph, and you're flying from right to left. To have your plane fly down the runway over the center line, you must point the nose to the right at some angle. A scale drawing can show you the appropriate compensation angle.

For this example, let's use a unit of length, e.g., an inch, to equal 10mph in a sketch as shown in Figure 1. This also shows graphically what the compensation angle should look like. Take note of this angle, as it will be a key measure of proper heading once your plane is in the air. While we're at it, why don't you try a few more sketches using 15, 20 and 25mph as your crosswind component; interesting, eh? (that's Canadian for "huh"). Don't put the sketchpad away yet; try the same drawing but with slower air speeds, like 75 and 50mph.

These sketches will work even if the crosswind is at an angle other than 90 degrees. See Figure 4, which illustrates a 20mph crosswind at 45 degrees. I'm not suggesting you take a sketchpad to the contest site, but this exercise gives you some idea of the relationship of air speed, the amount and angle of crosswind and how much compensation you may need.

VARYING THE ANGLE

Now that we've learned to compensate for a crosswind by pointing the nose into the wind at a particular angle, let's really put this technique to practical use. If you were to fly totally by the book, then, as your plane changes speed during its flight (as in a loop), you would need to change the compensation angle throughout the maneuver. The problem is that it doesn't look good, and if you're being judged, it usually doesn't score well. I've developed a few tricks of the trade that help hide the corrections. I've even been told it seems as though the crosswind has gone away.

It's really quite simple. During a pass, such as a slow roll, use more angle than is needed per the calculation noted above. Then, immediately thereafter, when you perform a stall turn or some vertical maneuver, use less angle. The compensation angle is hard to see during horizontal passes, so you can use more, but in the vertical maneuvers, the compensation angle really shows, so you use less. Overall, the average compensation is about right. Hence, you can maintain proper positioning, and it will look as if your plane handles a crosswind really well (but you and I know how it was really done).

FLYING THE ANGLE

Let's think about what it means to fly with the proper angle or heading. I've heard modelers comment, "Gee, sure is a strong crosswind today; your plane must have a very powerful rudder." Some people seem to think that to compensate for a crosswind, you must constantly fight it with rudder inputs. The truth is that once you have established the compensation angle, that's it; your control surfaces are at neutral, and your plane is in an aerodynamically stable position. There is no problem with weathervaning. It's impossible; the airplane is only "aware" of the relative wind. It doesn't know it's tracking right down the runway!

If you want to roll your plane perfectly down the center line of the runway, approach the center line with the correct heading for the wind, then roll. When performing the roll as you would in calmer conditions, the nose of the plane will continue to point at the pre-established heading. You will finish the maneuver with the heading you started with—and still be on the center line. Easy, eh? This is also true of a loop. Approach with the correct angle, perform the loop and voilà!

CHANGING ANGLES IN FLIGHT

As you gain altitude in a loop, your air speed will diminish, and the plane will be "blown in" to some degree if you keep the same angle. My advice is to add a little more angle as you gain altitude and lose air speed. Or you can just try to avoid huge loops, since the slower speeds they entail offer greater

exposure to crosswind. You'll have an opportunity to make up most of what you have lost on the down portion of the loop anyway.

When you're in competition, observe others to determine the compensation angles that might work best for you. And if you're up first? Oh, well—your experience and one allowable dead pass will have to give you an idea of where to start. After that, if you find yourself drifting in, add some more angle, and feel your way through.

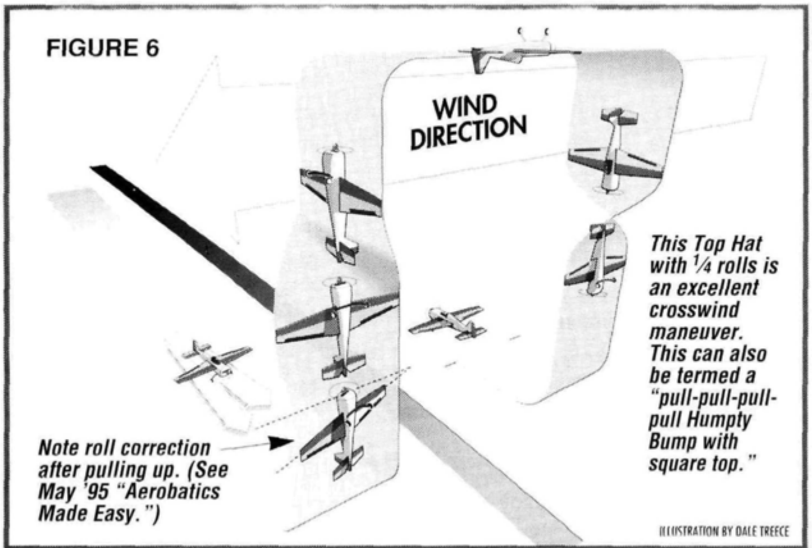


FIGURE 6

CROSSWIND FLYING POINTERS

- Are you going to alter heading during maneuvers to compensate for wind, or ignore crosswind and compensate via crosswind maneuvers?
- "Hang time" has a huge bearing on exposure in a crosswind.
- Start spins upwind.
- Think about wind direction and plan corrections; use vector drawings where helpful.
- Use more heading correction in level flight; less in vertical lines.
- On a vertical line, if you have a wind rudder correction inputted and you perform a ½ roll, you'll need opposite rudder after the roll.
- The more slowly you fly, the larger the heading adjustment needed.
- Concentration is vital to success.
- Practice in less than ideal conditions.

THE FULL-SCALE APPROACH

In full-scale aerobatics, it's nearly impossible for the pilot to compensate for wind. This is because he sits inside the cockpit. He does not have the great advantage that R/C fliers have: the ability to observe the aircraft from the ground. Full-scale aerobatics pilots don't even try to compensate for wind-drift during maneuvers. They simply make sure that heading and track are always the same. Instead of attempting to point the nose of the aircraft into the wind, they perform a crosswind maneuver that repositions the aircraft upwind.

There are two problems with this technique. If it is really windy, full-scale pilots can be blown right out of the box in which they are flying. This problem is compounded if they try to perform too many maneuvers between their crosswind maneuvers. The second problem is that, viewed from the ground, the maneuvers look more like they should if the pilot is compensating for the wind conditions to ensure perfect roundness and symmetry.

If it is calm, the pilot has a lot of freedom with the size of the crosswind maneuver. When the crosswind component is large, he has to take full advantage of the maneuver to place the aircraft as far upwind as possible. The crosswind maneuver can vary, but it is usually something like a Top Hat with ¼ rolls as shown in Figure 6.

Regular pattern flying allows compensation during the maneuvers, but in International Miniature Aerobatic Club (IMAC) contests, pilots fly by heading as in full-scale aerobatics. It's interesting to point out that at the TOC, which in many ways is an IMAC-style contest, changes in heading are allowed as in pattern contests.

As usual, practice makes perfect. Don't be intimidated by that crosswind; fly in it and learn! I hope this has shed some light on the crosswind subject, and I'll see you next month. ■

AIR SCOOP

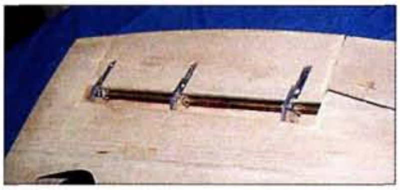
CHRIS CHIANELLI

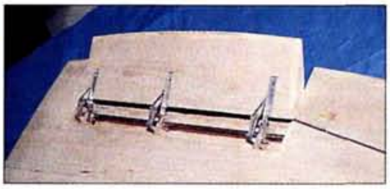
New products or people behind the scenes; my sources have been put on alert to get the scoop! In this column, you'll find new things that will, at times, cause consternation, and telepathic insults will probably be launched in my general direction! But who cares? It's you, the reader, who matters most! I spy for those who fly!

All in the Family

At the '95 WRAM show, held in Westchester, NY, we learned that Nick Ziroli Sr. (right) has sold his R/C plans business to his son. Nick Ziroli Jr. also owns an industrial vacuum-forming business called Specialty Model and Mold Inc. and makes fiberglass fuselages, cowls and canopies for his father's plans. Nick Sr. will now be able to devote more time to designing plans, which will then become available through Nick Jr. A 100-inch-wingspan Skyraider is in the works! We wish Nick Sr. a happy and busy retirement and Nick Jr. continued success with his business.

Shown in the photos below is the scale flap detail of Nick Jr.'s new Top Gun entry—the P-47 Thunderbolt. This mechanism, when complete, will increase airflow over the flap area by allowing a scale flap-leading-edge door to open and close just as it does in a full-size aircraft.





ASTRO'S NEW DIGITAL Microprocessor Peak-Charger

Astro Flight's new 115 AC/DC digital charger (powered by a 110V AC or a 12V DC battery) charges 1- to 8-cell packs of 100mAh to 2000mAh capacity at up to 5 amps. The unit, which has peak-detection capability in both trickle-charge and fast-charge modes, uses a new proprietary 8-bit digital microprocessor. The front panel features a start switch, four LED status indicators (ready, trickle, fast-charge and peak lamps), a current-adjustment control (the current stays constant during charging), an LED bar-graph ammeter that confirms the charging rate during fast charge and an 8A "re-setable" circuit breaker. List price: $109.95. A DC-only version that charges up to 8 cells (model 116) and an AC/DC version (model 114) that charges at a constant 4.5 amps and lacks the current adjuster and light bar each sell for $89.95. For more information, contact your local dealer, or Astro at (310) 821-6242.

MIDWEST PRODUCTS' Super Stinker

Midwest has just taken the wraps off its latest IMAA-legal offering—the Super Stinker. The full-size Super Stinker is the latest design from Curtiss Pitts, the father of the Pitts Special. Developed to compete against the more expensive IAC designs, e.g., the Extra 300S, the Cap 21 and the Russian-made Sukhoi, the Super Stinker is the most powerful, agile Pitts design yet. The 27-percent-scale model spans 60 inches, and it has an area of 1,240 square inches. It weighs between 12.5 and 16 pounds, depending on the powerplant used. Designed for a 1.2 to 2ci 2-stroke engine or a 1.2 to 2.7ci 4-stroke engine, the Midwest prototype is powered by a Moki 1.8 glow engine, and Midwest reports its performance is awesome. Look for Midwest's Super Stinker at your local hobby shop, or contact Midwest Products, P.O. Box 564, Hobart, IN 46342-0564; (219) 942-1134.

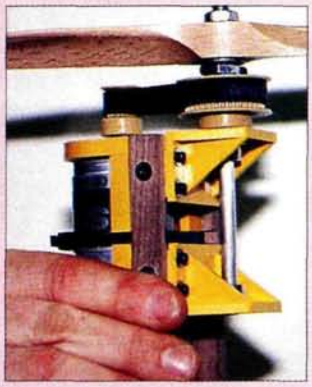
Hunt and Aberle Join Forces in Modelair-Tech

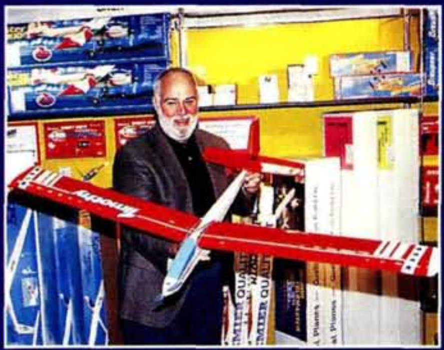
If you haven't already heard, Tom Hunt and Bob Aberle—two prolific model designers who, for decades, have made major and diverse contributions to the hobby (combined, they have 64 years in the hobby and 33 years of magazine article writing!) have formed a modeling company called Modelair-Tech. These guys are noted for their creativity and thoroughness, and we can hardly wait to see the products they will offer.

Shown in the photos is Modelair-Tech's new H-1000 belt-drive unit designed and developed by Tom Hunt. The unit can handle a variety of motors up to a 1,000W rating, e.g., Astro 25s and 40s, Speed 700s, most Ultra motors and Aveox brushless motors up to 16 cells. By swapping a single pulley, the reduction ratio can be easily changed at the field (ratios of 2.57, 3 and 3.6 to 1).

Want to fly a *big* plane on a budget? A special adapter permits the joining of two H-1000 belt drives. With a dual unit, you can use inexpensive ferrite motors to pull 1/4-scale models through the air. The H-1000 features a double ball-bearing-supported shaft and prop-adapter assembly.

Modelair-Tech will also offer semi-kits of three Tom Hunt designs originally kitted by Kress Jets, Inc.—the Pucara (61.5-inch span), a Beechraft D-18 (49.5-inch span) and the Republic A-10 Warthog (53-inch span). The kits will include foam-cores, full-size plans and vacuum-formed parts, and there will also be a range of innovative electric designs for which Modelair-Tech will sell the plans. All designs will also make great glow models. For more information, call (516) 979-1475, or write to Tom and Bob at P.O. Box 12033, Hauppauge, NY 11788-0818.





READY-BUILT, Speed 400 POWERED

Ready for flight, the 58-inch-span Timothy from Hobby Lobby Intl. is a ready-built electric sailplane that comes already covered with Oracover. This ship features conventional balsa rib/spar construction and weighs only 24 ounces when fully equipped. It has a super-low wing loading of less than 9 ounces per square foot, and this means long flights and great power-on performance.

The Timothy also features a tapered wing with an Eppler 205 airfoil, and it's designed to accept Graupner's direct-drive Speed 400 system and a standard 6-cell pack. Contact Hobby Lobby Intl., 5614 Franklin Pike Circle, Brentwood, TN 37027; (615) 373-1444.

Ace Simple Ultimate

The Ace R/C Simple Ultimate Bipe, shown here with Ace R/C president Joe Kessinger, is an intriguing new addition to the world of small-scale aerobatics. Designed by Fred Reese, the Simple Ultimate doesn't take long to build, and it offers exciting performance at a reasonable price. The wingspan is 33 inches, and Ace notes that the model uses a .10 to .20ci engine for sustained vertical rolls and blink-of-an-eye snap rolls. Other features include injection-molded foam wings; die-cut, lite-ply-and-balsa construction; and 4-channel operation. The Ace Simple Ultimate looks like fun scale at its best. Ace R/C, 116 W. 19th St., Higginsville, MO 64037-0472; (816) 584-7121.

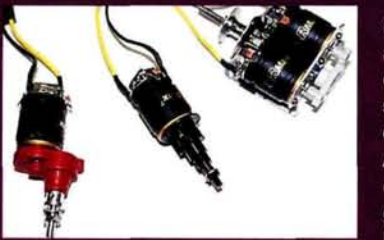
1/2A Scorpion ARF

This new ½A pattern aerobatics model from Cox Hobbies uses the new Tee Dee R/C .09 engine and is designed for optimum performance. The Scorpion ARF comes already covered with film, and it features a sheeted-foam wing and balsa-and-plywood fuselage construction. The wingspan is 40 inches, it has 290 square inches of area, and it weighs only 26 to 30 ounces. The kit includes hardware, decals, a fuel tank and lightweight wheels. Midsize servos can be used, but micro radio gear would improve performance by reducing the weight. The Scorpion ARF is just the ticket for parking-lot pattern flying! For more information, contact Cox Hobbies, 350 West Rincon St., Corona, CA 91720; (909) 278-1282.

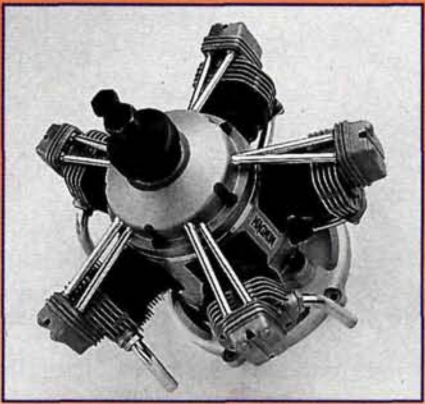
SR TAKES ELECTRICS TO THE MAX

"Competitive performance with increased efficiency." This was the design objective behind these two new motors from SR Batteries. The SR Max^{7} (for use with 5 to 7 cells) and SR Max^{10} (designed for 7 to 10 cells) neodymium, rare-earth magnet motors feature adjustable timing, dual ball bearings, replaceable brushes and an ⅛-inch-diameter shaft with machined flats.

SR designed the Max^{7} to be one of the most powerful and efficient 7-cell motors available, but the Max^{10} is designed to put out similar power with much less current on 10 cells (providing greatly increased run time). This is possible because both motors operate on approximately the same input power (330 watts), but from different numbers of cells.

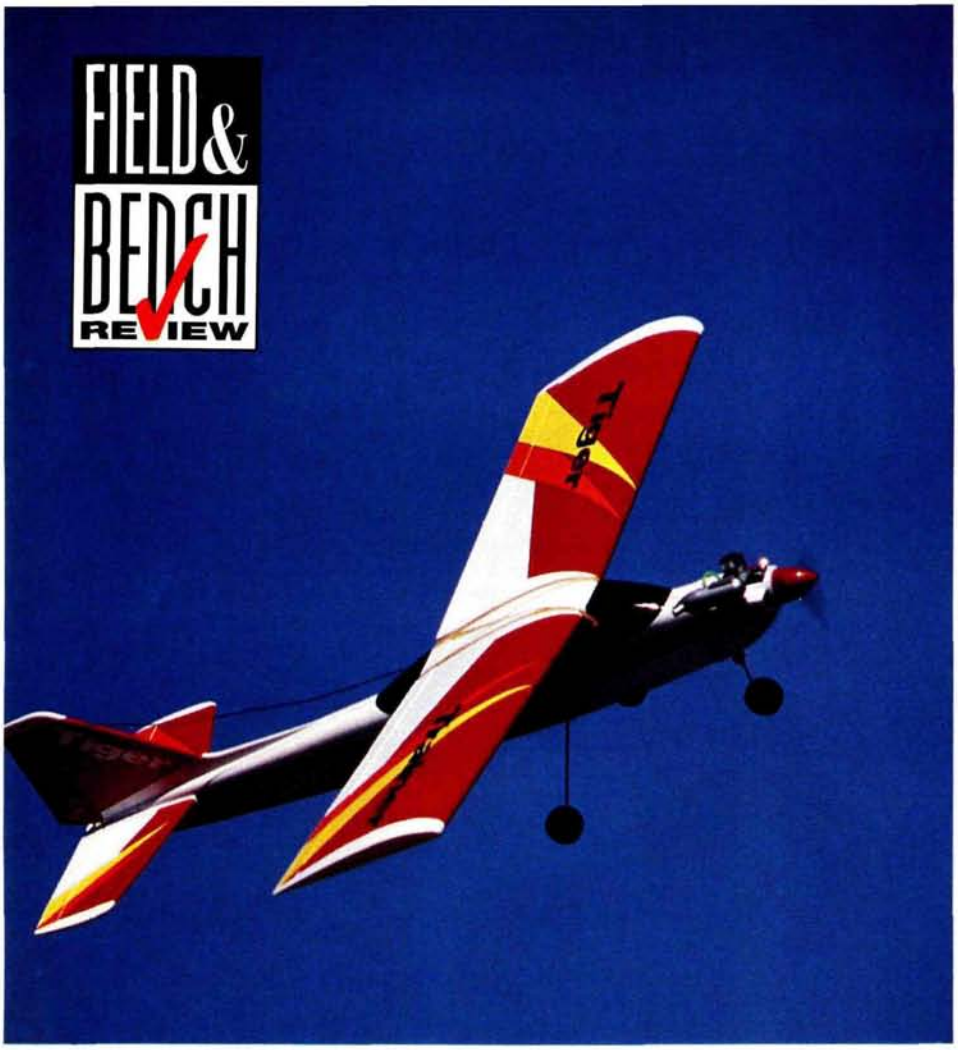


The motors are identical in size and come in direct-drive versions and with either a Master Airscrew (2.5, 3 or 3.5 to 1 ratio) gear drive or a Hobby Lobby 2:1 titanium gear drive. An Amp-Air twin-motor gear-drive setup is also available for both motors. For more information, contact SR Batteries Inc., Box 287, Bellport, NY 11713; (516) 286-0079.



NEW MAGNUM RADIAL

Attention lovers of large radials! Magnum Engines has introduced its newest CNC-manufactured engine—the 400XL-5R 4-stroke radial. The first of what promises to be a full line of CNC-built 4-stroke engines, the 5-cylinder 400XL-5R turns a 22x8 prop at a realistic 1,800rpm at idle and 6,500rpm at the top end. Even the engine mount for the 400XL-5R is CNC-machined from a single block of aircraft-grade aluminum alloy. According to Global Hobby Distributors—Magnum's exclusive distributor—initial testing of the early prototype engines has shown great potential. Expect delivery of this new, reasonably priced radial engine in late summer '95. For more information, contact Global Hobby Distributors, 10725 Ellis Ave., Fountain Valley, CA 92728-8610; (714) 963-0133.



Great looking and easy flying ARF

THUNDER TIGER

Tiger 40 Trainer

by FRANK MASI

THERE ARE A MILLION 40-size trainers out there. All share certain characteristics that make them ideal for new fliers: exemplary short takeoff-and-landing (STOL) capabilities and low-speed flight performance, simple yet rugged construction and, most important, very forgiving airborne manners. So, when you decide to finally get your "thumbs wet" and take up R/C aeromodeling, how do you choose from among the many trainer kits available when all appear to be pretty much the same? You should look closely at the small details. Some kits contain only the basic parts with which to build the model. You must then purchase all the small bits and hardware separately. If you're like me, finding out that you must make another trip to the hobby shop before you can go flying is a little disappointing.

The kit reviewed here is a new trainer from Thunder Tiger USA*; it's called the Tiger Trainer 40 (TT). It's a rudder, elevator and aileron-controlled trainer craft that not only

PHOTOS BY WALTER SIDAS AND FRANK MASI

Local flier Paul Zink (left) and the author ready the Tiger Trainer for its first flight.

comes with all its major components built and covered, but also includes everything you'll need to get up and flying, except engine, prop and radio system.

INSIDE THE BIG BOX

When you open the box, you're greeted by the sight of the brightly colored, pre-built-and-covered wing panels. The panels each feature conventional, built-up construction with balsa ribs and leading-edge sheeting and a beefy spruce-and-balsa box-type spar. The wing, as well as the rest of the flying surfaces, is covered with an attractive, red, orange and yellow-on-white film. Molded wingtips are already secured in place.

After marveling at the wing, the next "big thing" to grab your attention is the nearly finished fuselage. It's a unique combination of conventional balsa sheeting and lite-ply formers with a molded ABS plastic upper shell, which gives the fuse a slick shape that defies trainer

stereotype. The rearward portion of the shell features molded-in slots that align and retain the vertical fin and stab. When assembled, the plastic fairs nicely into the tail feathers.

The Tiger Trainer 40 has a few features that set it apart from the crowd, such as the molded upper fuse and molded cowl.

An engine mount comes already bolted to a fuelproof, reinforced, plywood firewall. Inside the fuse, there's plenty of room in which to mount standard-size radio gear, and there's a hardwood block affixed to the fuse floor to provide strength for the main landing gear.

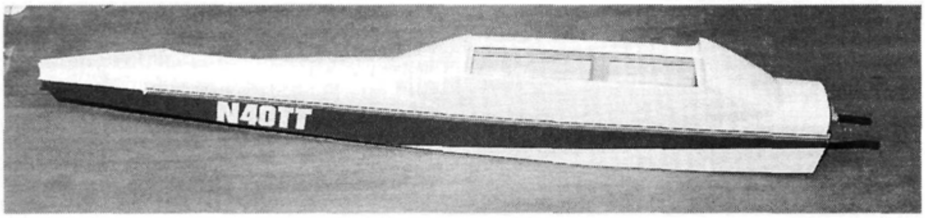
The pre-built stab and vertical fin are covered with the same attractive colored film as the main wing and fuse. Both the stab and fin feature molded tips, but where the vertical fin is of solid-balsa construction, the stab is a combination of solid-balsa and stick-type construction for a slight weight savings.

Once you've removed these major assemblies from the box, what remains is precisely what sets the Tiger Trainer apart from many of its competitors—a very complete hardware and accessory package. First is the topnotch, two-piece, injection-molded ABS cowl; it's pre-cut to fit most popular engines. Also included is a nice 300cc fuel tank that fits perfectly into the forward section of the TT's fuse. In addition, the kit contains a spinner set, tricycle landing gear with all hardware and tires, a complete pushrod set with guides for the steerable nose gear and throttle linkage and a full set of molded, point-style hinges for all control surfaces.

Finishing details include unique, black, molded "windows" and decals that enable you to continue the fuselage's color scheme onto the cowl. The plastic windows are glued to the molded portion of the fuse to simulate the front and rear windscreens.

BUILDING NOTES

The wing halves are joined at their centers with a laminated, lite-ply dihedral brace. The brace consists of three pieces of ply that you epoxy together and insert into each panel's box spar. I had trouble fitting the brace into the left-side panel and eventually trimmed about $\frac{3}{16}$ inch from one side of the brace using a razor-saw. Mine was a pre-production kit, and Thunder Tiger has assured me that they've had no complaints of similar problems from owners of production kits.



The Tiger Trainer's fuselage features a balsa bottom section and, for greater detail, a unique, molded upper section.

SPECIFICATIONS

Model name: Tiger Trainer 40

Type: high-wing trainer ARF

Manufacturer: Thunder Tiger USA

List price: $149.99

Wingspan: 61 in.

Wing area: 675 sq. in.

Weight: 5 lb.

Wing loading: 17 oz./sq. ft.

Length: 51 in.

Engine: Thunder Tiger GP-40 2-stroke

No. of channels req'd: 4 (aileron, elevator, rudder, throttle)

Radio used: Hitec/RCD Flash 5 5-channel

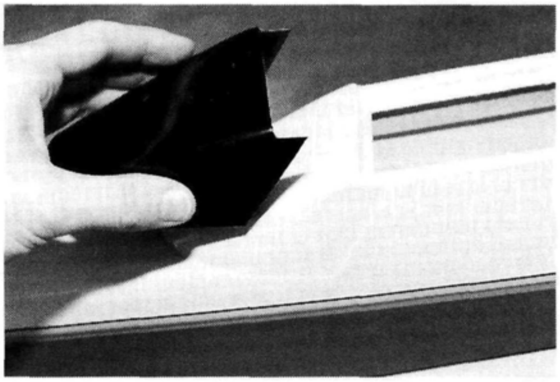
Kit construction: built-up balsa, lite-ply and spruce; molded cowl, upper fuselage and wingtips.

Features: kit includes fuel tank; spinner; adjustable, nylon engine mount; two-piece molded cowl; molded wingtips and upper fuse deck; all linkage and hardware. Instructions include helpful flying tips section.

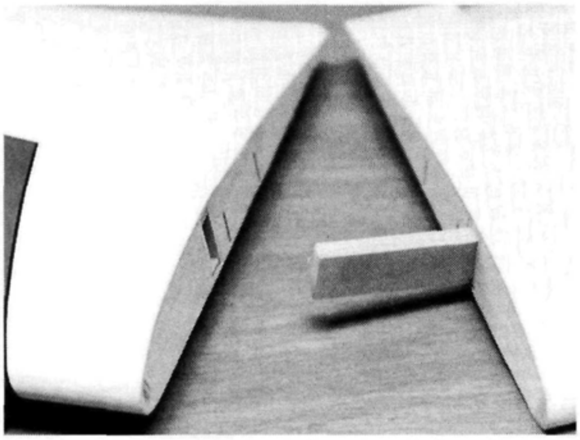
Hits
- Complete hardware included.
- Molded upper fuse and cowl add personality.
- Clear and detailed instructions.
- Overall excellent construction and finish.
- Excellent low-speed flight performance.

Misses
- Assembling wing halves requires some finesse.

Before epoxying the wing halves, make *absolutely sure* that you mark the back edge of the spar on the bottom of the panels. This mark is used to align the cutout for the aileron servo tray. I...um...forgot to make the mark but, fortunately, got lucky with a guess, so the cutout worked fine. Make nice fillets with epoxy when gluing in the tray; they'll add lots of strength.



Molded windows in the front and rear add realism and are easy to cut out and install; a few drops of thin CA hold them in place.



The wing halves are joined at their centers. A plywood dihedral brace inserted into the spar box section supports the structure.

The ailerons come attached to the wing panels with molded, point-type hinges. The hinges are only pushed into place, so you must remove them and re-attach them with glue. Using a small piece of pushrod material, I applied a dab of 5-minute Z-Poxy* into each hinge hole and held the assembly in place with masking tape to ensure the smallest gap between wing and aileron. A drop of light oil on the hinge pin helps prevent the epoxy from

FLIGHT PERFORMANCE

• Takeoff and landing

Takeoffs were from an asphalt runway in a slight cross wind. With its low wing loading, the Tiger Trainer becomes airborne after about 50 feet and climbs rapidly. Rotation is smooth and uneventful.

During initial flights, we had the chance to test the Tiger Trainer's power-off glide capabilities (we accidentally shut off the engine during flight). Even from a moderate altitude, there was plenty of glide time for a proper approach, and the plane never hinted at a stall. All landings were slow and easy and used very little runway. This was classic, easy, trainer flying.

• Low-speed performance

The Tiger Trainer is in its element when throttled back to about ¼. At low speeds and with about ½ inch of throw set on the ailerons, rudder and elevator, response is smooth, gentle and predictable. With a good instructor standing by, the novice pilot is unlikely to suffer any surprises.

With the engine running just into the midrange, you'd be hard-pressed to get this plane to stall. Low-speed stalls were straightforward and uneventful.

• High-speed performance

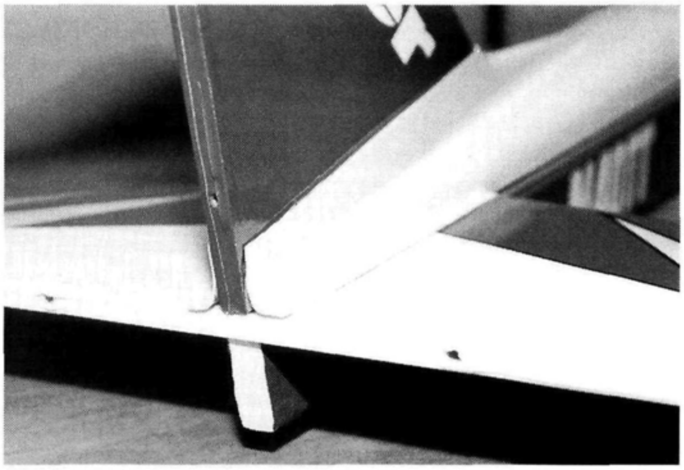
The Tiger Trainer is set up for low-speed flight. As built, higher speeds mean climb, climb, climb. If you want to go fast and fly level, plan to add down-elevator trim to compensate. As your skill progresses and your interest in slightly hotter performance grows, you could alternatively add a bit more downthrust or shim the rear of the wing slightly to lessen the angle of incidence. Once it has been trimmed for fast and level flight, the Tiger Trainer tracks well and actually flies quite briskly.

• Aerobatics

With a conservative amount of control throw, the Tiger Trainer could perform nice, easy loops and very slow, non-axial rolls. Inverted flight is possible, but it requires more down-elevator than is available in the suggested novice-flier setup. Increasing the control throws substantially increases responsiveness; this is recommended for more experienced pilots.

sticking and causing binding.

Gluing the fuselage fairing to the vertical fin and stab—without making a mess—takes a bit of patience. The goal is to form a tight bond without getting CA all over your great-looking tail surfaces. Use a fine applicator tube to pour the glue into the fairing seams, and carefully press the surfaces together until the glue sets. For the best results, do one seam at a time.



The rear portion of the molded fuse helps to align and secure the tail feathers. The plastic also fairs nicely into the stab and fin for a smooth look.

Installation of the various control linkages was simple and straightforward. Make sure that the nose-gear linkage operates as freely as possible, because any binding could impair rudder control and centering.

I opted to swap the kit's square-edged, foam landing wheels for a set of Du-Bro* Feather Lite tricycle wheels. They're also foam, but they're rounded and less likely to get snagged on small holes on a grass runway.

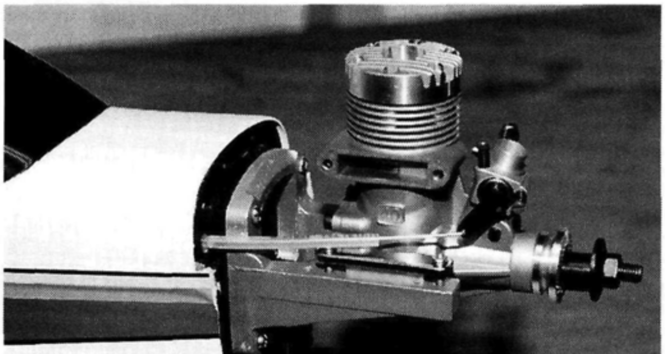
POWER AND CONTROL

I attached a Thunder Tiger GP-40 2-stroke to the TT's aluminum mount. Instead of using screws placed through the engine's mounting ears, this mount uses metal plates to clamp the engine into place. Careful alignment is critical here for proper thrust. For starters, I attached a Master Airscrew* Scimitar profile 10x6 prop.

Hitec/RCD*'s new Flash 5 5-channel system seemed to be the perfect radio for this project. Three of the HS-422 servos fit perfectly into the plane's plywood radio tray, while the fourth fits into the wing's aileron servo tray, albeit a bit tightly. Hitec supplies a piece of neoprene-foam rubber with which to wrap the receiver to protect it from shock and vibration—a nice touch.

SUMMARY

Thunder Tiger has put together a nice package for the novice flier. The Tiger Trainer 40 has a few features that set it apart from the crowd, such as the molded upper fuse and molded cowl. A well-written illustrated instruction manual effectively guides the builder from construction through the first few flights. It features accurate depictions of all parts and hardware, step-by-step photos keyed to text and some useful flying tips. All in all, it's a complete kit with forgiving performance and enough special touches to avoid "look-alike" status. Thunder Tiger also offers a 25-size and 60-size version of the Tiger Trainer.



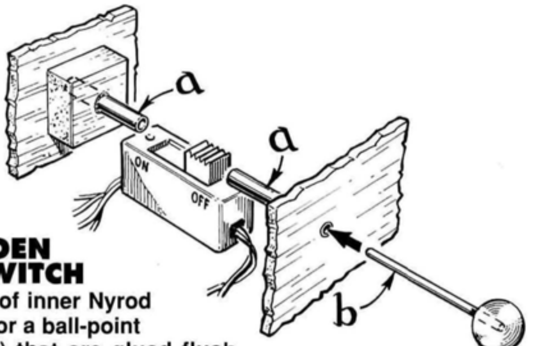
The included, cast-aluminum, clamping-type engine mount provides great freedom for engine placement. Thunder Tiger's new GP-40 ABC engine fits perfectly. [Editor's note: a new, nylon engine mount is now included with the Tiger Trainer 40. Its beam width is adjustable to accomodate engines from .20 to .46ci displacement.]

*Addresses are listed alphabetically in the Index of Manufacturers on page 130. ■

HINTS & KINKS

JIM NEWMAN

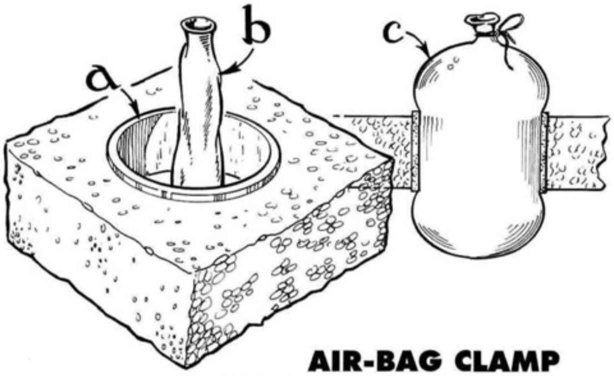
Model Airplane News will give a free one-year subscription (or one-year renewal if you already subscribe) for each idea used in "Hints & Kinks." Send a rough sketch to Jim Newman c/o Model Airplane News, 251 Danbury Rd., Wilton, CT 06897. BE SURE YOUR NAME AND ADDRESS ARE CLEARLY PRINTED ON EACH SKETCH, PHOTO AND NOTE YOU SUBMIT. Because of the number of ideas we receive, we can't acknowledge each one, nor can we return unused material.



HIDDEN SWITCH

Pieces of inner Nyrod tubing or a ball-point tube (a) that are glued flush with the fuselage sides guide the wire pushrod (b) so that the switch can be hidden yet can easily be turned on and off by pushing the switch knob from either side. Note the large colored bead or wooden knob that's on the rod so it can easily be seen in the grass. A Radio Shack flashing LED in the cockpit will show whether the radio is on or off.

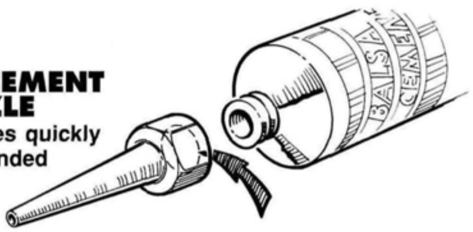
Bob Fields, Tucson, AZ



AIR-BAG CLAMP

This longtime modeler uses an inflated balloon (b and c) to keep the balsa lining of a wheel well (a) in contact with the foam-core while the glue sets up.

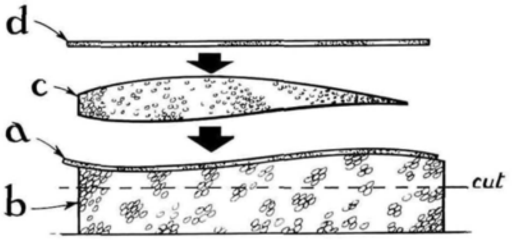
Bob Noll, Vestal, NY



BALSA-CEMENT NOZZLE

Because it dries quickly and can be sanded easily, balsa cement is still a handy adhesive. The arrow shows where to modify this CA tip; drill out the inside with a no. 9 drill bit (0.196 inch)—a little less than 5mm. This allows the tip to be screwed onto the cement tube for more controlled application. A Sig no. 20 pin is a good stopper.

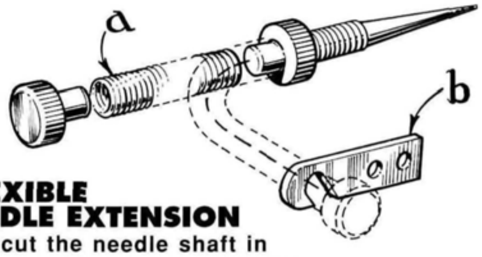
Harold Hellman, Darien, IL



WARP-FREE SKINNING

First tack-glue the foam lower nest to an absolutely flat surface, then, with 3M77 applied *only* to the nest, tack-glue the lower skin (a) into that nest (b). Now bond in the core (c) followed by the top skin (d). To remove the wing, just hot-wire cut through the nest about ¼ inch (6mm) below the wing and peel off the foam.

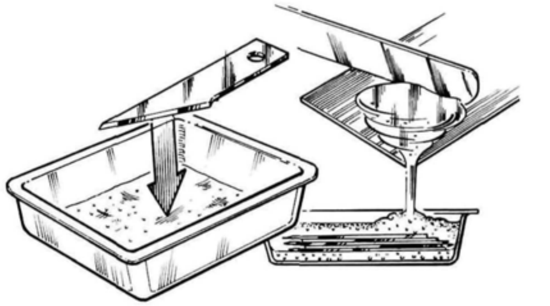
Merv Mathews, Palmerston North, New Zealand



FLEXIBLE NEEDLE EXTENSION

First, cut the needle shaft in two, then solder a length of flexible spiral-wound curtain rod (a) to the shaft as shown. This allows the needle to be angled back from the propeller arc while you make adjustments, after which the shaft can be clipped under a nylon or metal bracket (b).

Bob Robert, Durrington, Wilts., England

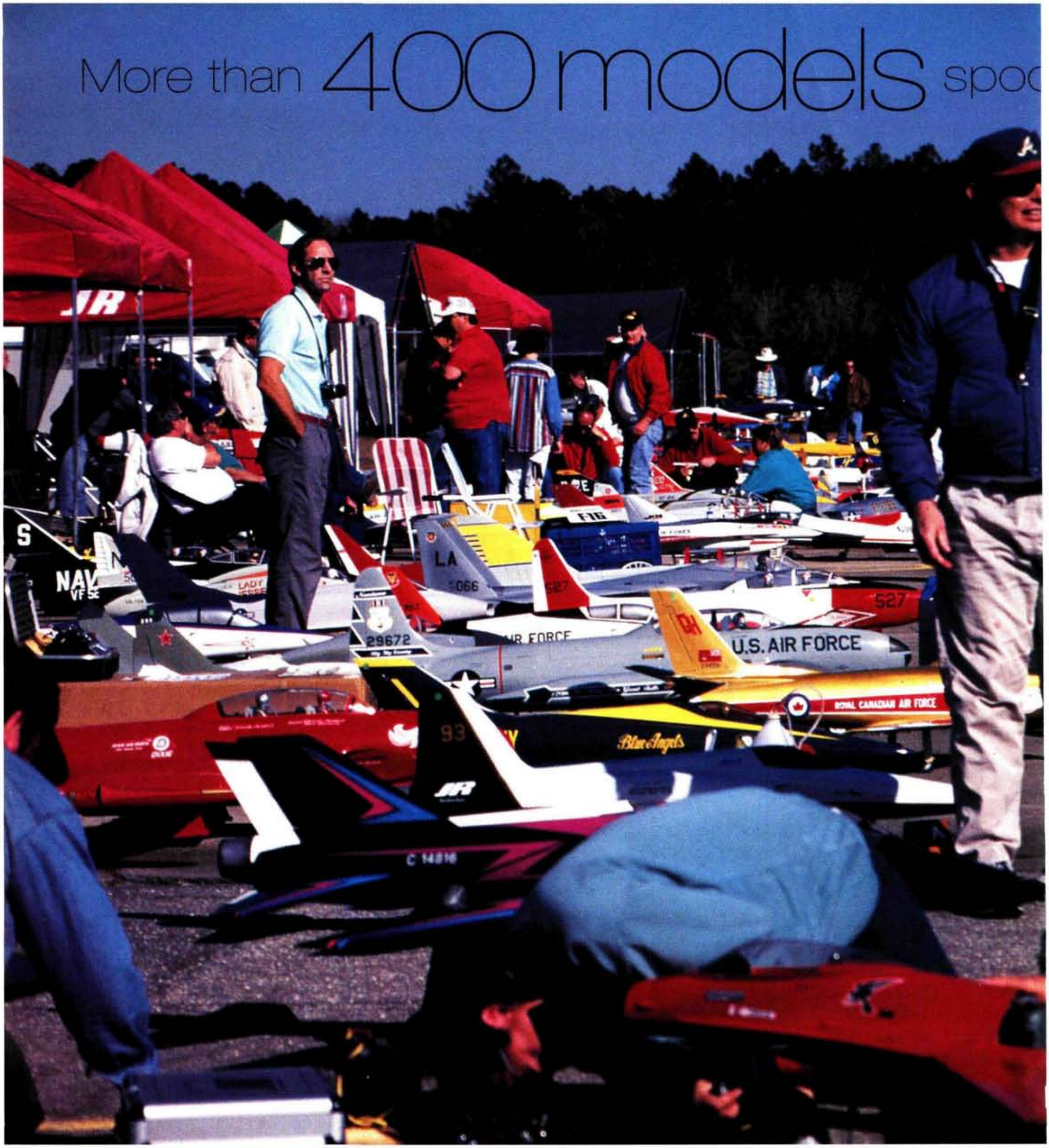


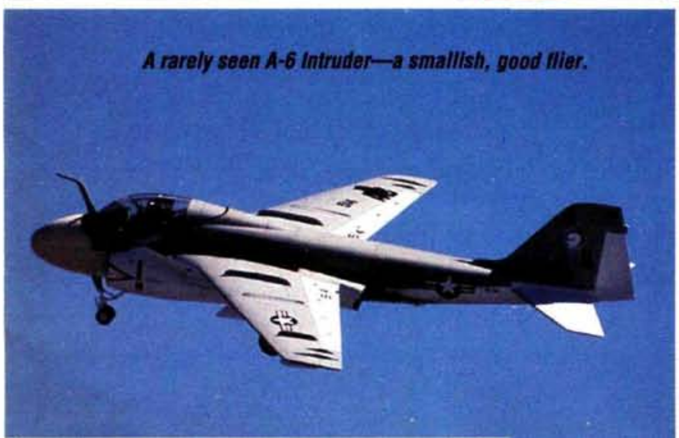
SAFE BLADE DISPOSAL

Scrape your epoxy dregs into a plastic jelly container and dump your old blades onto the glue. When the container is filled with blades, scrape some more epoxy dregs on top. After the epoxy has set, your potentially dangerous blades will be nicely encapsulated and can be safely put into the garbage.

Steve Arnoczky, Sandusky, OH

More than 400 models spoo





A rarely seen A-6 Intruder—a smallish, good flier.

Bob Boswell's F4D Skyray from the Mark Frankel design; it's powered by an O.S. .91 with a Ramtec fan.

6TH ANNUAL INTERNATIONAL JETS OVER DELAND

STORY AND PHOTOS BY DAN PARSONS

THE GOLDEN HAWKS R/C Club of Deland, FL, again hosted the world's largest gathering of R/C pilots and their ducted-fan/turbine planes. The sixth annual Jets Over Deland Fly-In was held on January 26 through January 29, at the host club's excellent facility, which boasts a 1,600x200-foot concrete runway and plenty of pit area and parking. A total of 180 pilots filled the 600-foot-long pit with more than 400 planes. These 180 pilots came not only from all around the U.S., but also from 11 other countries. For enthusiastic jet R/C'ers, this meet is a must!

"Big Red" Yellow Aircraft F-18 Hornet with Seymour's SWB 40-pound thrust turbine pushing it.

Mike Lesher's F-15 from the Avonds kit. The 15-pound plane is powered by O.S. .91s with Ramtec fans.

Tom Cook and Jeff Seymour's T-33 from the Cook (JMP) kit is about to touch down. It's powered by Seymour's SWB 20-pound thrust turbine engine.

NEW AND IMPROVED

I arrived on Thursday morning, and flying was already under way. After checking in with the CD, Al Tuttle, and getting my press pass, I toured the pits. It was immediately obvious that the jets have joined the "big bird" movement. The neat thing about this is that all the large jets are scale, and many require only one engine. This has been made possible by several design developments: more powerful engines, proper inlet and outlet design, improved ducted-fan design and the judicious use of composite materials to increase strength while reducing weight.

Award Winners

Best Scale Models

Pos.	Pilot	Plane
1	Clark Hopkins	P-33 (BVM)
2	Mike Burke	F4 Phantom
3	James Smith	F9F-3

Best in Show: Clark Hopkins—P-33 (BVM)
Best Original Model: Yves Duchesneau—Cyclone
Best Sport Model: Pat McCurry—Maverick (BVM)
Best Military Model: Les Burfiend—A-6

Entering this scene of engineering prowess is the ultimate: the development of practical turbojet engines. And turbine-powered planes were out in force this year, with at least twice as many flying as last year. (More on these marvelous and almost unbelievable engines later.)

ON THE TARMAC

In the pits, the first friend I ran into was Mike Lesher. I asked what plane he had brought, and he replied, "An F-15 from the Avonds* kit." Because that's one of my favorite jets, I had him take me straight to it.

Examining the fine workmanship that's typical of Mike, I went around the nose and started to check over the left side. Immediately, I spotted the pilot's name—Captain Skip Robertson—printed as it is on full-scale military planes (just below the canopy's bottom edge). I was surprised and pleased because Skip, an F-15 pilot instructor, is an R/C'er acquaintance of mine who now flies ducted fans.

Ron Sorg's 12-pound BD-10 from the Appelbaum kit about to land. KBV 82, Viojett.

As it turns out, Mike also knows Skip, and when Mike decided to build an F-15, he asked Skip if he could supply some pictures of the F-15 that he flew in the Gulf War. Skip was happy to oblige; so Mike is now flying an F-15 with the exact color and markings of the F-15 that Skip flew over Iraq. Unfortunately, Skip could not make this meet, but I bet he would really have enjoyed Mike's skillful flying of "his" F-15.

"FAN"-TASTIC FLIERS

By midmorning Thursday, the five flight stations were continuously busy. The first big bird ducted fan to blast off was a MiG 29 fighter powered by two Russian-built Angstrem .91s. After a steep climb-out to about 500 feet, pilot Wolfgang Klühr put on an impressive demonstration of the capabilities of this fine model. The Russian .91s turned Ramtec* fans, and it appeared that the power-to-weight ratio of this 10.5-kilo (23.1-pound) model was close to scale.

Wolfgang Klühr's big, twin-engine MiG 29 commencing a very steep climb after takeoff. The 23-pound plane is powered by Russian Angstrom .91s with Ramtec fans.

Though necessarily restricted in maneuvering by the four other planes in the air, it was obvious that Wolfgang was a topnotch pilot. He has been the German national scale champion three times. Wolfgang's MiG 29 is from his own kit, which, unfortunately, is not available in the U.S. With a 100-inch-long fuselage and a wingspan of 69 inches, this is a large model, but because it weighs only 23 pounds, it's very nimble and has outstanding vertical capability.

Winfried Ohlgart, my interpreter with Wolfgang, was the head organizer of the large group of pilots and their assistants who came from Germany. Because he has solid experience in ducted fans, he writes the jet column in the German magazine *MFI*.

After telling me about Wolfgang and his MiG 29, Winfried showed me one of the very powerful Russian Angstrem .91 engines. It turns a Ramtec fan at 21,800rpm vs. 20,000rpm for an O.S.* .91. The O.S. 91 is no slouch as a fan engine. Questioned as to the Angstrem's longevity, he replied, "We've run 40 liters through this engine, and it's holding up fine." He then remarked with a grin, "It's our secret weapon!"

Bob Fiorenze's F-18 Hornet from the new Yellow Aircraft kit; it's a good flying machine, and it's fast.

I had been keeping tabs on Mike Lesher because I didn't want to miss his first flight at this meet with his F-15. Shortly after Wolfgang had landed his MiG 29, Mike taxied out his F-15 (somewhat smaller than the MiG, but still a good size). He made a long, straight takeoff run and climbed out nicely. With only one engine, it didn't have the tremendous vertical performance of the MiG. But, because the F-15 weighs only 15 pounds, the O.S. .91 provides a spirited performance that would satisfy most pilots. And think of the simplicity and lower cost of only one engine—and much lower weight. This large, 15-pound model will fly slowly under perfect control and is a great touch-and-go machine with its graceful landing-pattern approach.

A rare model indeed, an A-6 Intruder taxied out for takeoff. Its small size didn't dampen my interest because I had never seen a ducted-fan model of this plane fly. After a violent pitch up on takeoff (I figured it was a goner), the pilot made a good recovery and put in a solid flight. I can't believe that I didn't get information on this smallish cutie; something distracted me, I reckon.

PHANTOM IN THE SKY

Undoubtedly, it was Bob Violett's big F-4 taxiing out for takeoff. I had seen this plane (in primer gray) perform at this meet last year. This year, it had all the goodies in finish and markings; it looked as though Bob had gone to a Naval air station, found an F-4, sprayed it with "instant-shrink" and brought it to this meet. Absolutely gorgeous!

Back to the runway. Bob lined up his F-4 with the runway center line, set the brakes, partially powered up his BVM* .91s then released the brakes. As he continually added power, it accelerated rapidly and smoothly. After a long, scale-like takeoff run, he

pulled it off and maintained about a 70-degree climb right on up to about 1,000 feet. Spectacular!

As with other pilots who were flying large, high-powered, interesting (and very valuable) planes, Bob was unable to show the F-4's full capabilities because of the other aircraft in the air. He worked in a long, slow roll and then a long 4-point roll. His dive in from about 1,000 feet for a low pass was awesome. Throughout the flight, his BVM .91s ran flawlessly and sounded as though they were right together. Because the F-4 weighs only 25 pounds, those BVM .91s give it tremendous performance. To date, Bob has 55 flights on it; that's a bunch. I suggested to Bob that his F-4—with its good size and estimated level speed of 175mph—would make a great chase plane for the unlimiteds flying in the R/C Reno-style racing. He agreed but quickly added, "Not with mine."

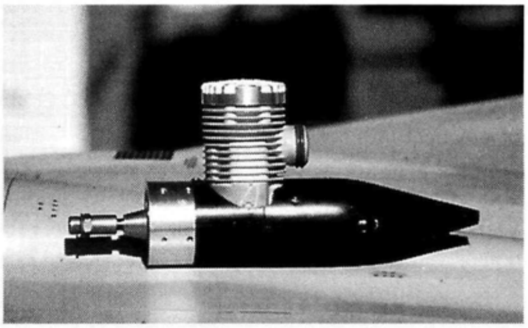
SPOOLIN' UP

So where are the turbines? New is Jeff Seymour's T-33 from the Jet Model Products* (JMP) kit, with Jeff's planned-for-production SWB* kerosene-burning turbine engine installed. With an 84-inch wingspan, this is a large, impressive model. The plane weighs 34 pounds, but the 25 pounds of thrust available provided outstanding performance. JMP's Tom Cook told me he used full throttle only on takeoff and during steep climbing maneuvers. Flying straight and level, he used only half throttle. He did this for two reasons: to reduce fuel consumption (greatly) and to prevent overly stressing the plane owing to high speed. The plane carries 2 quarts of fuel, and 1 quart was used up in 6 minutes from start of the turbine to shutdown. Again, like the other pilots, Tom was very limited in his flying routine because of the other planes in the air.

Bob Violett's latest creation, the F-4 Phantom, was pushed to awesome performance by two BVM .91s.

Jeff Seymour expects his SWB production turbine to be available in June 1995. It will produce 20 pounds of thrust. And by the way, Jeff is installing his turbine in one of Mark Frankel's F4D Skyrays; *that* I've *got* to see fly!

There were several "small" (or standard-size) jets flying, and they were powered by the French JPX* turbines, which use propane (switching to kerosene sometime this summer). Many flights were made by a Saggitario, a Rafale C and a Fiat .91 (a new plane to me), which looks something like a plump F-86. The many flights that took place with no problems certainly championed the reliability of these turbine engines.



The new Russian Angstrom .91. According to the German fliers, it's a very powerful engine.

Also powered by a JPX turbine was Kent Nogy's T-33 from the BVM kit. It used a DK T240 that had its nominal 9 pounds of thrust boosted to around 12 pounds by careful intake ducting and exhaust-tube design. The T240 provided very good performance for Kent's 19-pound (dry) BVM T-33. These turbines are thirsty, so he had to carry 40 ounces of propane. Having flown a JPX T240-powered BVM Viper in demos all over the country for several years, Kent certainly has more "turbine time" than anyone else (at least in the U.S.).

One thing is obvious: turbines are here to stay. This meet proved this in several ways: turbines are reliable; they provide tremendous power; they're realistic; they're quiet; and, finally, because every jet modeler I talked to during this four-day meet would give his right arm to power his favorite jet with one.

PUSHING THE ENVELOPE

For a complete change of pace, how about an electric-powered ducted-fan flying a MiG 15? Dave Ribbe designed and built it, and he flew it at this meet last year, but I missed it (I'm always looking for the big, fast, twin-engine planes—serves me right).

I wasn't prepared for what I saw: a very aerobatic, great performing little cutie that made flights lasting for sev-eral minutes. The absence of noise was eerie. Dave is best known for setting speed records with his BVM Viper—in the 225 to 230mph range. What a contrast and challenge! My hat's off to you, Dave!

A small, twin-rudder plane took off and immediately caught my attention because I didn't recognize this good-looking newcomer. It was well worth watching because it flew smoothly and steadily with none of the wing rocking that's seen on many jets. I tracked down the pilot—Dan Puckett—and the builder/owner—Ron Sorg. Ron told me it was a 1/5.5-scale version of a BD-10 and said he built it from the kit by Paul Appelbaum*. At 11 pounds, it's powered by a KBV* 82 driving a Viojett fan. Every time I saw it fly, it was the same; fast, rock-steady and smooth with excellent vertical performance. During one flight, I stood next to the pilot who, on this flight, happened to be Ron Sorg. I noticed that Ron's hands were shaking so hard that I was surprised he could fly. And yet, his BD-10 was rock-steady and smooth. Impressive.

I kidded Ron about his shaking, then confessed that I sometimes do exactly the same thing while flying my deHavilland Hornet twin; and I've been flying it for 12 years. Ah, isn't R/C the greatest hobby going!

SMOOTH OPERATOR

One of the pilots I most enjoy watching fly is Jeff Foley, who put his 24-pound T-33 from the Tom Cook (JMP) kit through its paces. And why do I enjoy Jeff's flying so much? Primarily because he flies his plane so smoothly. No one in R/C flies any more smoothly. Of course, his maneuvers, too, are

A Sukhoi 27 on a low, high-speed flyby. Powered by two O.S. 91s with Ramtec fans, it's a fine flier.

essentially flawless (he flew pattern for six or seven years).

I'm trying to make a point here about smooth flying. There is nothing, and I repeat, nothing that helps create the illusion of full-scale flying more than smoothness of flying. This is especially true of scale models.

Jeff powers his T-33 with an O.S. .91 turning a Dynamax* fan. This is a perfect combination, providing just the right power and speed for Jeff's rolling maneuvers plus excellent vertical performance for his large, round loops and large, smooth reverse Cuban-8s, etc. I judged one of Jeff's flights from taxi-out to taxi-back and scored him a 98.

Instead of flying his big twin-engine Yellow Aircraft* F-18 Hornet this year, Bob Fiorenze flew the wings off Yellow Aircraft's latest offering: a much smaller, single-engine F-18 Hornet powered by an O.S. .91 and a Dynamax fan unit. It's a fine performer and fast enough for just about any ducted-fan flier. His low passes were rock-steady and spectacular.

THE EAGLE FLIES

Late on Friday afternoon, after the sun had gone down and all the pilots had apparently quit for the day, the silence was broken by a twin-engine F-15 blasting down the runway then lifting off and climbing steeply to about 1,000 feet where it did a split-S and came screaming down at full power for a 3-foot-high, long, low pass over the far edge of the runway. This got my attention!

The pilot pulled up from the low pass into a huge loop and then proceeded into a series of steep reversing turns with no straight flight in between. Then he slowed things down and did a series of tailslides, stalls and what appeared to be attempts to spin. From this, he got back up to speed, did a long, slow roll followed by a long 4-point roll, followed by a straight-in high approach to the runway with the overhead pitch out and around to a perfect landing. Much of his flight reminded me of the often repeated TV coverage of the full-size MiG 29 strutting its stuff several years ago at the Paris Air Show.

And the pilot who put on this great show? Per Strommen, who lives in Norway and flies Boeing 767s for Scandinavian Airlines. His F-15, built from the Avonds kit, originally sported two K&B* 45s, but Per wanted more performance, so he installed two O.S. .91s turning Ramtec fans—and performance he got! It was the most spectacular solo flight of the meet and was only possible because no other planes were in the air.

Per Strommen's F-15 from an Avonds kit. It's powered by O.S. .91s instead of K&B .45s.

DOUGLAS DELTA WINGS

Mark Frankel and Bob Boswell brought two F4D Skyray Navy fighters. Designed by Mark Frankel several years ago, the Skyray isn't well-known and is seen at few meets. At this meet, Bob Boswell went a long way toward improving that situation. I didn't keep score, but I'm sure that he flew his Skyray more than any other plane was flown at this large, busy fly-in. Bob figured he flew it at least eight times on Friday alone.

Being large, relatively slow, very different looking (rounded, delta-configured wing) and painted a highly visible orange and white guaranteed that this plane would be noticed. If that wasn't enough, Bob's expert handling, many flights and especially his many touch-and-go's really caught people's attention. He performd smooth, high-angle-of-attack, high-drag approaches and used power on the main gear to control the rate of descent right to perfect touchdowns on the main gear—really a treat to watch. That he did many touch-and-go's (rare with ducted-fan scale models) just added to the fun for the appreciative spectators. What a great touch-and-go machine!

Mark didn't fly his contest Skyray; he was too busy and having too much fun pitting for Bob. In fact, they were having so much fun that they invited Charlie Lines, Jeff Seymour, Carl Spurlock and me to have a turn with this outstanding fun machine. We all did well, especially Carl. I'd like to have one just to shoot touch-and-go's! I almost forgot the specs on this fun plane: weight—19 pounds; engine—O.S. .91 turning a Ramtec fan housed in a Cook (of JMP) shroud. It flashed through the speed trap at 107mph. Bob said he had put at least 275 flights on his F4D Skyray.

ON FINAL

Carl Spurlock brought the T-33 that he designed and built. With an 82-inch wingspan, it's halfway between Violett's 80-inch T-33 and Cook's 84-inch T-33. Powered by the new K&B 100 turning a Byron* fan, it weighs 19.5 pounds and performed very well. While talking to Carl, I found out he has designed planes for Byron Originals. Course, my next question was, "Is Byron planning to kit it?" He replied, "Maybe." Al Tuttle was a bit more specific; he said anyone interested in Carl's T-33 should call Byron Originals.

By oversleeping on Sunday morning, I missed one of the best—if not *the* best—flying displays of this entire meet. In a spur-of-the-moment action, Bob Boswell with his F4D Skyray and Carl Spurlock with his A-7 Corsair made a formation takeoff and then put on a show of synchronized flying that people will be talking about for a long time.

Nearly perfectly matched in speed and performance, they did flybys together and rolls and loops together. But the pièce de résistance was a low pass with Bob's Skyray inverted at about 20 feet and Carl's A-7 Corsair passing directly under the Skyray. They finished off their great show with a side-by-side touchdown. And these pilots had never before flown together! This type of flying is an absolute indicator of what outstanding pilots they are. Congratulations, Bob and Carl, for having put the perfect final touches on a really fine "jet-together" (and thanks to Dan Vincent for originating such an appropriate term). Congratulations and many thanks to contest director Al Tuttle, his hard-working crew, the Golden Hawks R/C Club and the many generous sponsors (see list).

Sponsors

Ace Hobbies (South Daytona)
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Yellow Aircraft
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Lanny Lucas

**Addresses are listed alphabetically in the Index of Manufacturers on page 130.* ■

PILOT PROJECTS

A LOOK AT WHAT OUR READERS ARE DOING

SEND IN YOUR SNAPSHOTS

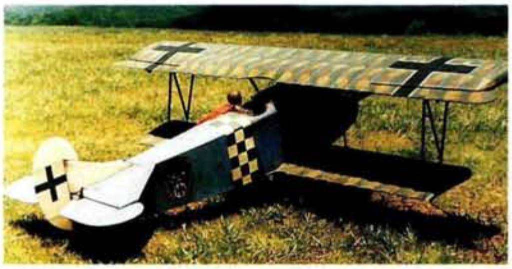
Model Airplane News is your magazine and, as always, we encourage reader participation. In "Pilot Projects," we feature pictures from you—our readers. Both color slides and color prints are acceptable.

All photos used in this section will be eligible for a grand prize of $500, to be awarded at the end of 1995. The winner will be chosen from all entries published, so get a photo or two, plus a brief description, and send them in!

Send those pictures to: Pilot Projects, Model Airplane News, 251 Danbury Rd., Wilton, CT 06897.

SCANNED DAM BUSTER

Laurence Stenhouse of Jacksonville, NC, scratch-built this huge British Mk.1 Lancaster bomber with the help of his computer. Using drawings from Argus Books' *Aircraft Archive Bomber of WW II*, Laurence scanned the images into his computer and then used the Design CAD 2D program to create the plans for the model. Construction is balsa and lite-ply with a few fiberglass parts formed over foam plugs; the finish is Perfect paints over Parsons fiberglass and epoxy resin. Powered by four O.S. .70 Surpass 4-stroke engines, this 124-inch wingspan bomber weighs in at 47 pounds. All the clear canopies and turrets were vacuum-formed. A Hitec radio with JR and Tower servos control this astonishing Avro Dam Buster.



FRONTLINE FOKKER

Joe Parrott of Knoxville, TN, scratch-built this great-looking weathered and detailed Fokker D-VII using Joseph Nieto drawings. Joe enlarged the Nieto drawings to 1/6 scale, and he powers the model with an O.S. .91 Surpass 4-stroke engine. The finished weight is 8 pounds, and the model is a pussycat to fly. Joe hand painted all the markings, including the lozenge pattern on the wings. His next project will be a 1/4-scale version!

TEXAS TELEMASTER

Chuck Balof of Harker Heights, TX, shows off his new, modified Telemaster 2000 ARF. Chuck's friend Stewart Brouillette helped with the project by extending the wing to an IMAA-legal 80 inches. Features include a Saito FA-80 Gold 4-stroke engine, three-position flaps and a cargo area for future use. Each aileron and flap section has its own servo, and Chuck installed a 1200mAh battery. Covering is MonoKote and Ultracoat film.

ULTIMATE PURPLE PASSION

Nineteen-year-old Nick Radle of Riverside, CA, built and modified this beautiful Carl Goldberg Models Ultimate biplane and says that, with a YS 120 in the nose, its vertical performance is more than unlimited. Nick has been flying R/C for 11 years and can really wring out this 9-pound, 3-ounce purple beast. Nick modified the Ultimate to strengthen and lighten the airframe, and he covered it with MonoKote. Mods include a fully sheeted bottom wing, stainless-steel cabanes, lightened and polished aluminum landing gear and fiberglass cowl and wheel pants.

TWIN-TAILED TRAINER

Dick Visker of TA Rijen, the Netherlands, sends us this snapshot of his creation—the Super Pusher. Starting with a Tiger 2 wing, Dick added twin tail booms made out of two old fishing rods, and he built the fuselage and tail parts using balsa and plywood. The model is powered by an O.S. .40 4-stroke engine, and it flies well using throttle, elevator and aileron (no rudder control). The Super Pusher is dressed in Oracover film covering.

PILOT PROJECTS

PUSH 'N' PULL PROJECT

John Lutz of Erwinna, PA, built this red-and-white Cessna 336 Skymaster as his first true scale model. The Skymaster has a wingspan of 76 inches and is powered by twin O.S. .35s that are fed by two 12-ounce fuel tanks. The interior is complete with a fully detailed instrument panel (including Storm Scope radar), and it has a black-and-gold velour finish. The engine compartments have polished brass liners, and the model is painted with Centari automotive paint. For his next project, John wants to build a 10-foot Cessna 310.

CARBON-COPY CUB

Bill Fulmer of Houma, LA, sent this photo of his Great Planes Cub sitting next to its full-size counterpart. His modifications include: clipping the wing to a 67½-inch span; scale struts with exposed aileron cables; interplane struts; detailed main gear and tail wheel; Fiberglass Specialties cowl with an exhaust and drains; and a custom-machined skullcap spinner. The Cub's cockpit details include instruments, throttle quadrants, front and rear seat backs and a ⅕-scale William Bros. pilot that looks amazingly like the owner of the full-size plane—Gordon "Papa" Cargile of Columbia, SC.

50% PITTS

David Matthews of Co. Clare, Ireland, built this impressive ½-scale model Pitts Special S-1S, which is an exact replica of the full-size aircraft owned by Robert York of St. Augustine, FL. Powered by a Quadra 100cc gasoline engine turning a 39x17 prop with a 2.15:1 gear reduction, the model is made completely of wood and has hardwood dowels where steel tubes are used in the full-size Pitts. The 108-inch-span, 48-pound model is covered with doped nylon and has a two-part epoxy finish. All radio gear is in the area under the pilot's headrest; it includes two receivers, four battery packs (redundant backup system), two 1200mAh battery packs for the receiver and two 2500mAh 6V packs for servo power. All the metal fittings were homemade; the only things David didn't make were the engine, the prop and the wheels. The model flies very scale-like with the prop turning 3,100rpm.

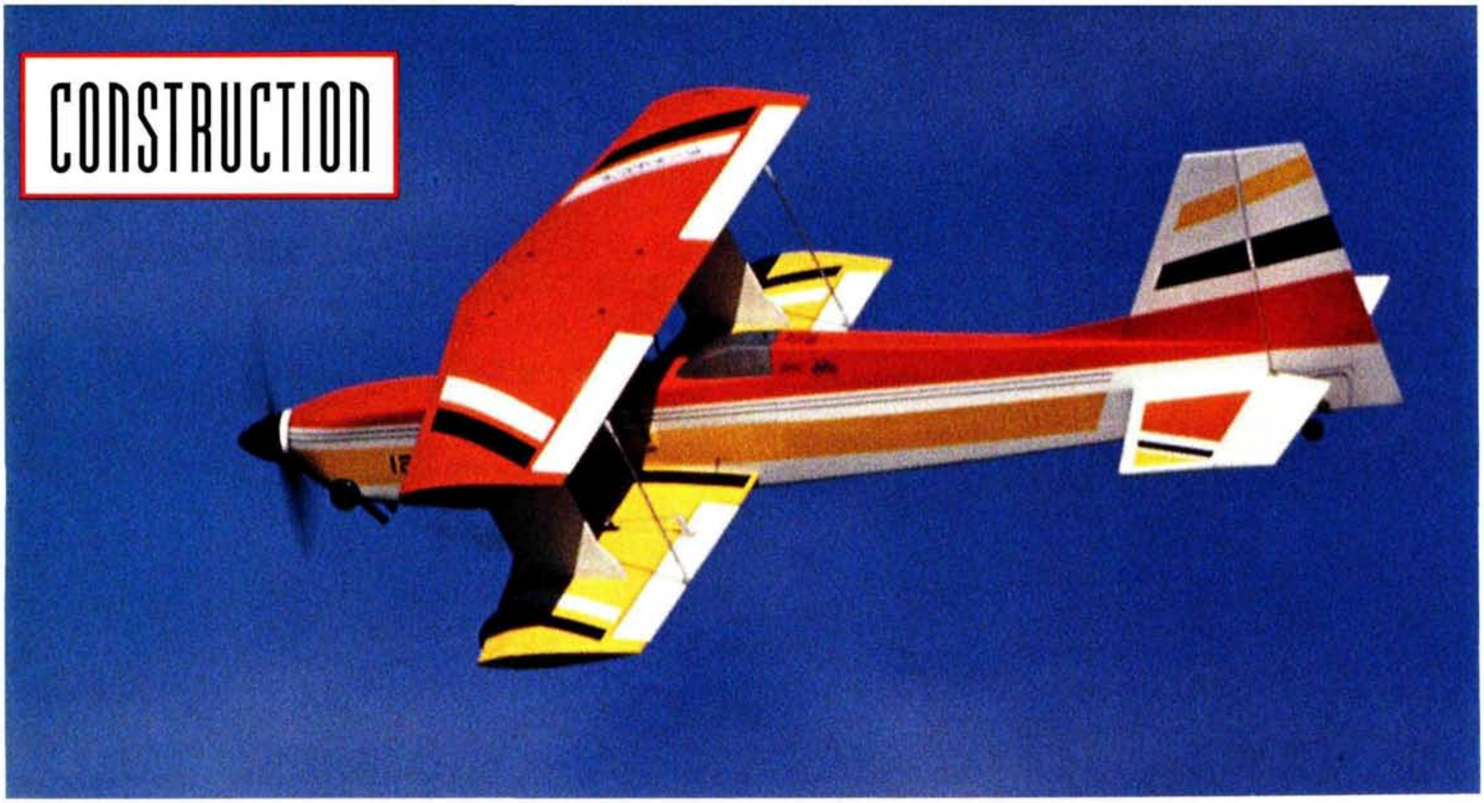
THUNDEROUS T-BIRD

Air show announcer Sam Write took this photo of Garland Hamilton's T-33, which is painted in striking Marine colors. Garland built it from a Bob Violett Models kit and added inner main-gear doors to the already highly detailed model. He has flown his T-Bird at many scale contests, including Top Gun and the Scale Masters.

CAN'T BEAT THIS FLEET

Aubrey Nabers of Sautee, GA, tells us that his dad started him in modeling even before he went to school. His Fleet bipe is from the Concept kit, which he structurally modified with one-piece wings, carbon-reinforced spars and Jerry Nelson flying wires. The model is covered with fabric and dope, and it uses a Saito 3.25 radial engine. Aubrey says, "I think this airplane/engine combination is going to be my favorite."

CONSTRUCTION



THE HUSKIE Aerobatic Bipe

High performance with style

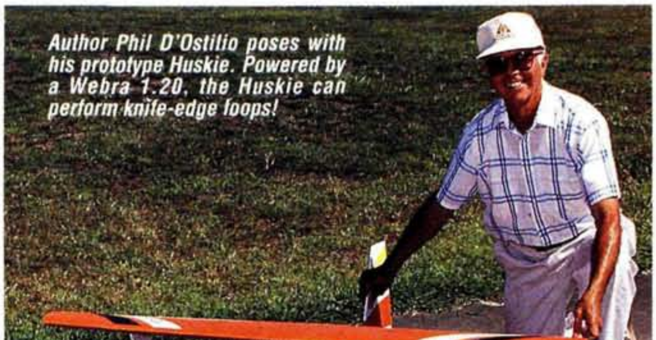
by PHIL D'OSTILIO

CURRENT R/C aerobatics thinking favors enlarging models to gain better flight qualities, such as reduced speed (for added realism) and improved performance (for the execution of more complex maneuvers). I followed this thinking when I designed my Huskie aerobatic bipe. But it isn't a simple matter; many variables must be considered.

SIZE AND WEIGHT

The biggest challenge is to increase the model's size without adding so much weight that performance is affected. Figure 1 shows a graph of gross weight versus wing area; it was derived from several mid-wing aerobatic models that were constructed using similar methods and materials. The reference line isn't linear (not a straight line) and is useful to estimate the gross weight of a model for a given wing area.

For the Huskie, I selected a total wing area of approximately 8 square feet and, from the graph, I determined that a gross weight of 12.5 pounds would result if I built the model in a mid-wing configuration. When the lift required for a given model weight is shared between two smaller wings (as in a biplane), the gross weight of that model will be less, partly owing to the reduction in wing component weight. The graph shows the resultant weights of 10 pounds for the model when built in a biplane configuration.



Author Phil D'Ostilio poses with his prototype Huskie. Powered by a Webra 1.20, the Huskie can perform knife-edge loops!

This 2.5-pound weight-saving differential indicates that this biplane configuration saved 21 percent in weight compared to the mid-wing configuration. Performance-wise, this weight reduction contributes to a lower landing speed and better vertical acceleration and vertical climb rate.

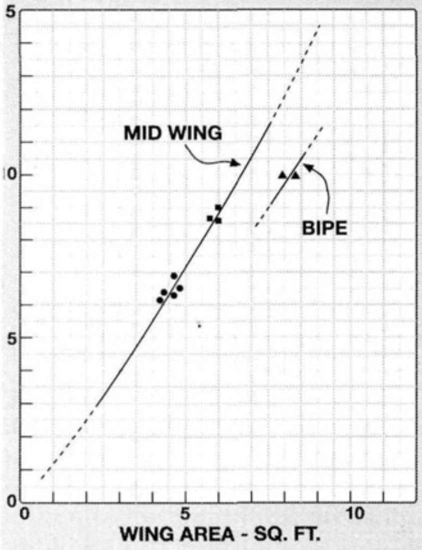
MANEUVER ENVELOPE

The Huskie's aerobatic performance is especially impressive where fuselage lift becomes a factor. Maneuvers such as sustained knife-edge flight at minimum and maximum speeds; knife-edge loops and knife-edge vertical turnarounds are examples. Figure 2 is a simplified illustration of the principal vertical forces involved in steady knife-edge flight and in the initial entry for a knife-edge loop. This simplified and briefly described closer look at the biplane configuration provided the basis for my

B&W PHOTOS BY PHIL D'OSTILIO; COLOR PHOTOS BY TOM ATWOOD.

igure 1

GROSS WT. vs WING AREA CONFIGURATION COMPARISON



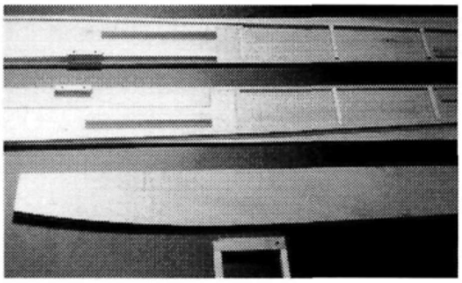
:cision to go ahead and build the prototype odel, i.e., a lower gross weight for a given ·ea and lift benefits from fuselage and ıterplane struts for lateral flight conditions.

esign features include:

Aerodynamically clean nose for improved ·op efficiency and lower fuselage drag.

Symmetrical dihedral profile for minimal ıw-roll coupling.

Minimum weight at the wingtips for lower ›ll inertia and better damping.

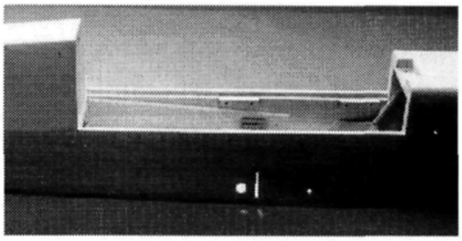


The fuselage sides, lite-ply doublers, servo side rails and maple cabane-strut base supports. Note that the excess balsa sheeting has yet to be trimmed away from the lower fuselage longerons.

- Plug-in lower wing panels for structural continuity of the fuselage in the landing-gear area.
- Aileron servos in the upper surfaces of each bottom wing panel to allow easier adjustments and monitoring.
- Hatch/canopy can be removed for radio access; no need to remove a wing.
- Aircraft may be easily assembled and disassembled in an upright position.

CONSTRUCTION

• Top wing. The foam-core wings are sheeted with 1⁄16-inch-thick balsa. *[Editor's note: cut foam wing- cores are available for the Huskie bipe from RA Cores, P.O. Box 863, Southbridge, MA 01550; (508) 765-9998; racores@worldstd.com; price—$30 for both top and bottom wing-cores and tail cores.]* After you've cut the foam-cores to shape, add the soft balsa sub-leading-edge strips to the front of them. These strips increase rigidity,



The vertical slots in the fuselage sides accept the lower plug-in wing-panel plywood spars. The hole to the right of the slot is for the nylon, wing-panel retainer screw. The larger hole is for the aileron cable connector. Note that the internal antenna sleeve is already in place.

provide a good bonding surface at the leading edge (LE) for the sheeting and help to keep the panels straight.

Sand the LE strips to match the core's airfoil contour, and add the sheeting with epoxy resin. I prefer to vacuum-bond the sheeting, although evenly distributed weights are OK for holding the sheeting in place. When the sheeting has been glued into place, add the balsa LE and final-sand to shape. The top wing panels are joined at the center with their lower surfaces flat on the workbench. Note that the 1⁄8-inch-thick plywood strip spar is only added to the wing's underside. After the spar strip has been installed, apply glass cloth over the area shown on the plans to increase strength at the cabane-strut attachment area. Epoxy several drilled and counter-bored 1⁄2-inch-diameter wooden dowels in the places shown on the plans to form receptacles for the cabane attachment screws.

Figure 2

VERTICAL FORCES FOR SUSTAINED KNIFE-EDGE FLIGHT

A summation of the vertical forces is:
Equation (1):

$$T_V + L_F + 2\,L_{IPS} - L_{VT} - GW - D_V = 0$$

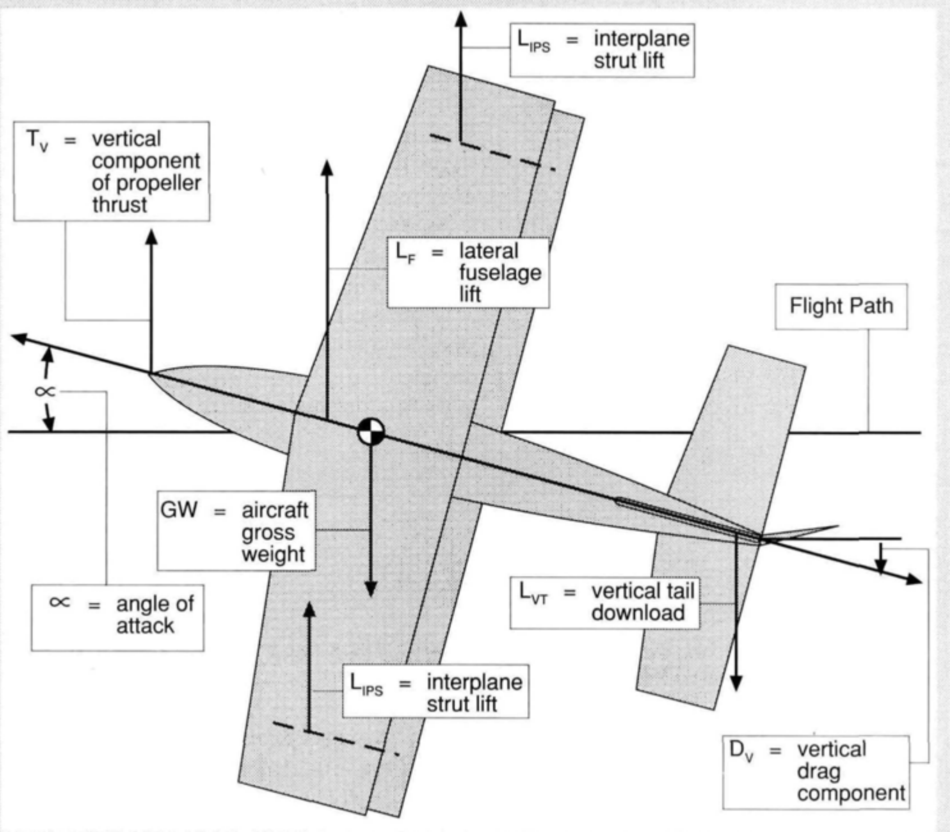
Using the basic lift equation: $L = C_l\,qS$
Equation (1) now becomes:

$$T_V + q(C_l\,S)_F + 2q\,(C_l\,S)_{IPS} - L_{VT} - GW - D_V = 0$$

For a given engine/propeller selection, terms that the designer can consider for more lateral lift are:

- (C_l) fuselage lateral lift coefficient.
- (S) fuselage lateral area.

The above also applies to the interplane struts. Therefore, increasing the lateral area of the fuselage (S) and the surface areas of the interplane struts (S), adding several struts, and perhaps the strut airfoil section, appear to offer design options. The fuselage lift coefficient (C_l) is not easily improved without extensive experimentation. Of course, keeping the gross weight down and the aircraft aerodynamically clean are also important.

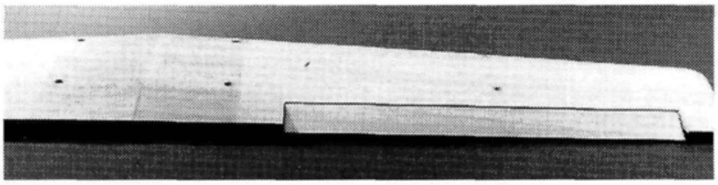


• **Bottom wing.** The lower wing panels are attached to the fuselage with plug-in spars and are held in place with nylon wing bolts. Two, identical, $\frac{1}{8}$x1$\frac{1}{4}$x12-inch spars are inserted into the $\frac{1}{4}$-inch-wide recesses cut into the panels. Saw-cut these recesses carefully and accurately to achieve zero-degree incidence and ensure that the panels will be properly mated to the fuselage sides. The top of the plywood/balsa spar unit must be epoxied flush with the core's top surface.

Next, make the servo bays in the upper surfaces of the wing panels, make the aileron cutouts, cap the aileron cutout opening with balsa, and install the hinges. Glue the hinges in place permanently after the wings and ailerons have been covered. Use a cardboard template when you mark the aileron areas on the wings' surfaces to ensure that both ailerons are the same size. The wingtips are simply cut at about 45 degrees and capped with balsa sheeting. To act as interplane strut mounts, $\frac{3}{8}$-inch-diameter wooden dowels are installed in the wing panels. They're drilled through for 4-40 screws.

SPECIFICATIONS

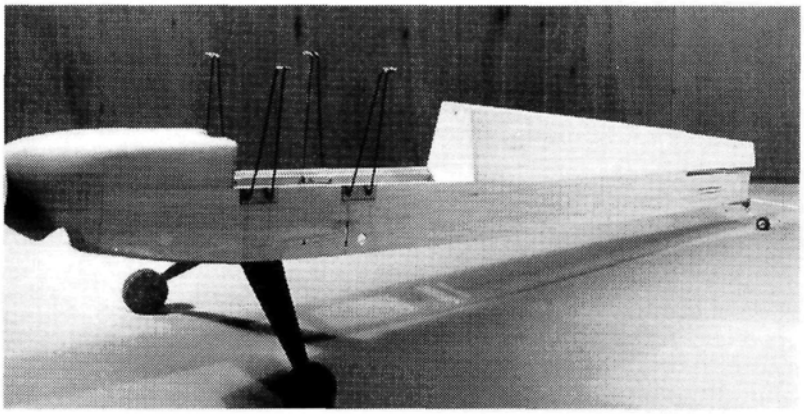
Type: sport aerobatics bipe
Wingspan: 60 in. (both wings)
Root chord: 12$\frac{7}{8}$ in.
Tip chord: 9 in.
Wing area: 1,247 sq. in.
Airfoil: NACA 0015
Gap/average chord ratio: 1:1
Stabilizer span: 26 in.
Stabilizer average chord: 9.7 in.
Stabilizer area: 252 sq. in.
Vertical tail height: 13 in.
Length: 61 in.
Weight: 10 lb. (160 oz.)
Wing loading: 19 oz. per sq. ft.
Engine used: Webra speed 120 with Davis Model Products; Pitts-style
Propeller: 16x8, APC
Fuel tank: 16 oz.
Channels and servos req'd: 6—throttle, aileron (2), elevator (2), rudder
Materials used: balsa, foam, plywood



The center section of the top wing is fiberglassed for strength. Note the drilled and counter-bored dowels used for the strut-mount attachment points.

FUSELAGE

To form the sides, use $\frac{1}{8}$x4x48-inch balsa sheets. The top edge must be straight because it's the model's thrust line and is a reference line for the subsequent alignment of the wings and the horizontal tail.



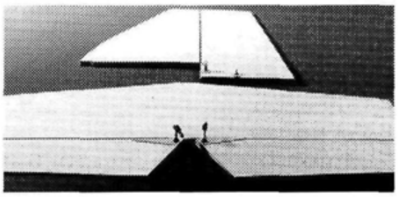
The Huskie fuselage is aerodynamically clean and compact. Note that the bottom of the balsa cowl is recessed to take the Davis Pitts-style muffler.

Building sequence:

• Glue on the $\frac{1}{8}$x$\frac{1}{4}$-inch top longerons (splice if necessary).

• Make the fuselage doublers out of $\frac{1}{8}$-inch-thick lite-ply, and epoxy them into place with their top edge up against the top longerons. Remember to make left and right fuselage sides.

• Glue the $\frac{1}{4}$-inch-square lower longerons into place using the lite-ply doublers' lower edge as a guide.



The tail surfaces are light, torsionally rigid balsa-sheeted foam.

• Glue the vertical uprights, balsa stabilizer reinforcement strip and tail end filler strip into place followed by the servo side rails, trailing-edge reinforcement pieces and the maple cabane blocks.

• Trim the excess balsa side sheeting flush with the lower longerons.

• Assemble the fuselage by gluing F1, F2 and F3 into place while the fuselage rests on its side.

• Recess the lower longeron (in the area shown on the plans) to accept the plywood landing-gear pieces, and glue them into place.

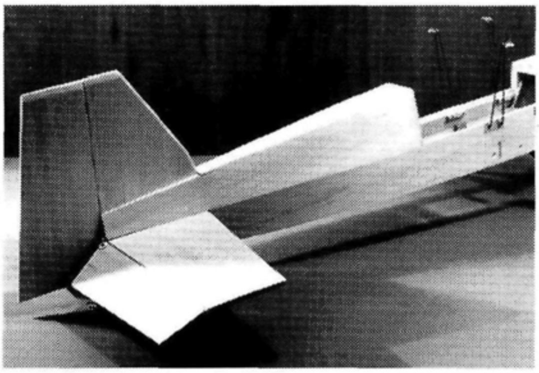
• Make the top forward contoured fuselage assembly as shown using $\frac{3}{4}$-inch-thick soft balsa.

• Glue the upper engine rail into place with epoxy. The lower engine rail is first glued to $\frac{3}{8}$-inch-thick balsa and is then positioned on F1. Soft balsa is used to build the cowl.

• Form the stabilizer slot in the fuselage by cutting along the top of the $\frac{1}{8}$-inch reinforcing strip.

• The removable hatch is a foam block sheeted with $\frac{1}{16}$-inch-thick balsa. The hatch is sheeted after the foam has been contoured to match F4. Glue $\frac{3}{16}$-inch sheet balsa to the hatch's top surface.

• The turtle deck side pieces consist of $\frac{3}{32}$-inch balsa sheeting epoxied to $\frac{1}{4}$-inch-thick foam. So that you'll be able to sand the foam at an angle to make a flat bonding joint, allow it to extend $\frac{1}{8}$ inch over the top and bottom edges. Because of the aft fuselage curve, the lower edges of the turtle-deck sides will also need a slight curve. Sand it to match. With F4 in place, add the turtle deck sides to the lower fuselage (use aliphatic glue).

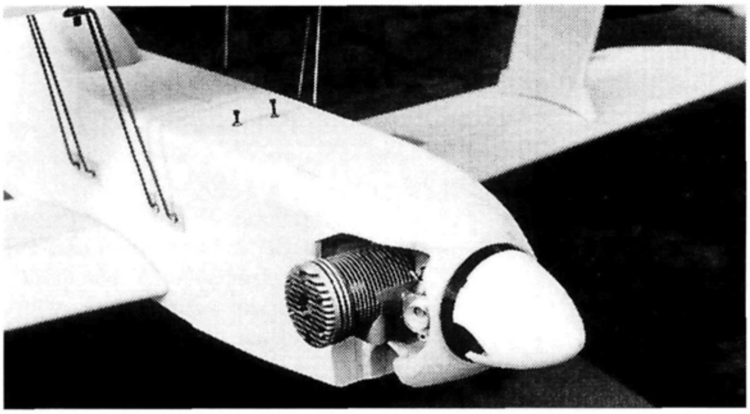


The horizontal tail is mounted on the thrust line and positioned in a slot. The vertical fin is centered between the turtle-deck sides.

• Soft balsa is used to form the canopy. The plans show a simple latch mechanism that makes it easy to remove the canopy/hatch assembly. Alternatively, you could put 4-40 nylon screws on both sides of the hatch.

• In each side of the fuselage, make a cutout for the lower spars. Rest a small square on the thrust line to ensure that the cutouts are 90 degrees (to the thrust line), and reinforce them with plywood pieces.

• From the engine cowl to the landing-gear mount plate, the bottom of the fuselage is covered with $\frac{1}{8}$-inch cross-grain balsa sheeting; and $\frac{3}{32}$-inch longitudinal-grain sheet balsa runs from the landing-gear mount plate to the plywood tail-wheel base plate.



I power the Huskie with a Webra Speed 120 equipped with a Davis Pitts-style muffler. Exhaust residue exits downward and rearward to leave the aircraft clean. The engine cowl is formed out of balsa.

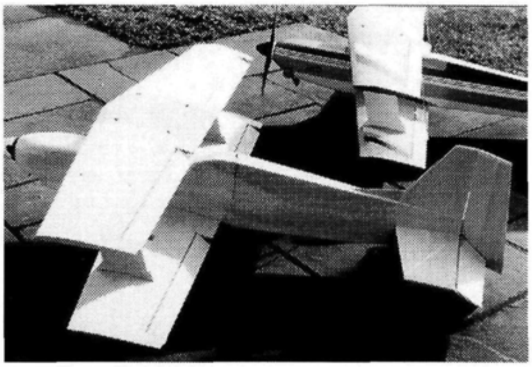
• Prepare the fuselage for covering and finishing by sanding all the contours and surfaces.

• **Interplane struts.** To make the interplane struts, add 1⁄16-inch-thick cross-grain balsa to a 1⁄8x4-inch soft-balsa core. Cap the leading and trailing edges with balsa and sand them to shape. The top and bottom edges should be parallel. Glue plywood strips to the top edge of each strut, and install 4-40 T-nuts in it to match the drilled 3⁄8-inch-diameter dowels in the top wing.

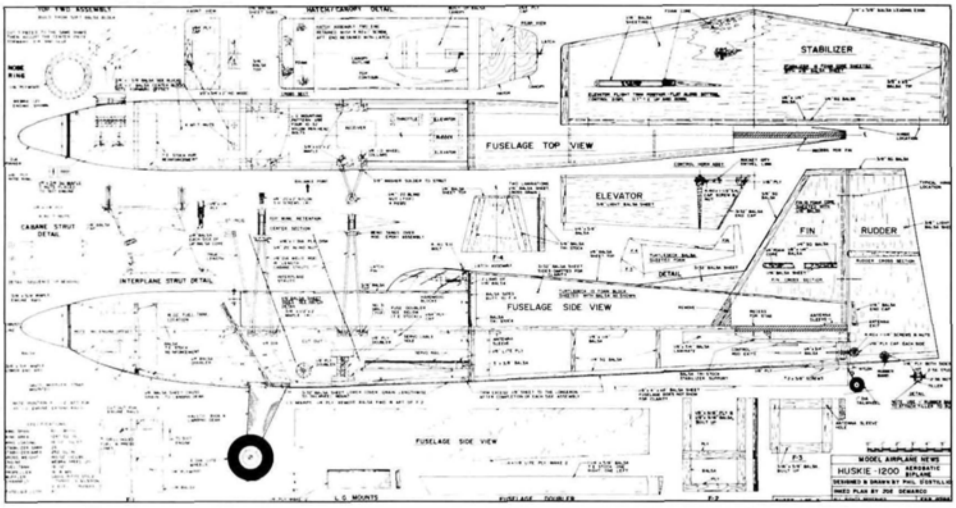
With the top wing and lower panels in place, install the interplane struts on the bottom of the top wing, and then trim the lower edge of the interplane struts as necessary, retaining the parallel edges. Position the lower plywood strip so that its mount holes match the dowel holes in the lower panels, and glue the strip to the interplane strut. Add balsa caps to provide shear strength for the plywood strips and balsa core. Then add filler pieces to complete the strut assembly.

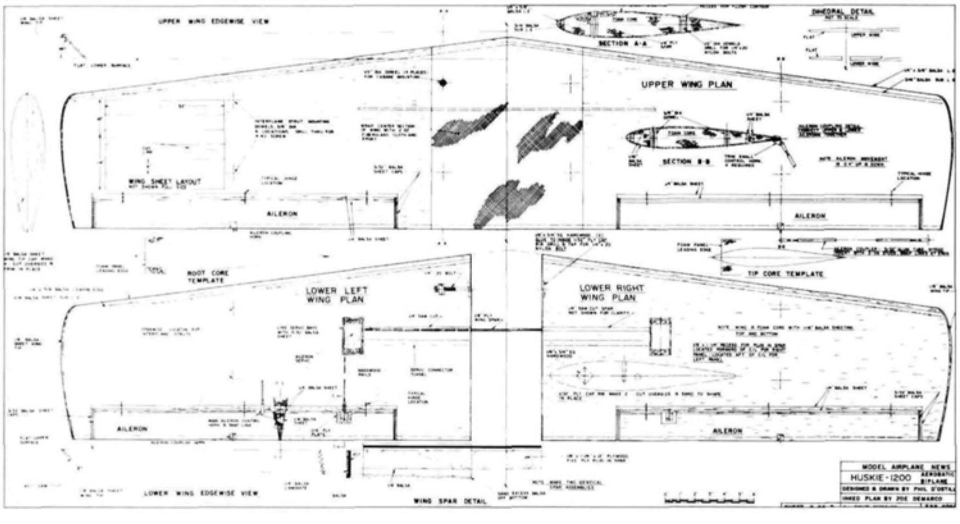
• **Cabanes.** Cut two 36-inch-long welding rods to make four 18-inch lengths, and follow the bending sequence illustrated on the plans. Use 1⁄4-20 T-nuts as anchor nuts for the 2-inch-long, nylon 1⁄4-20 wing-attachment screws. Nylon nuts can be used instead of the T-nut arrangement shown on the plans, but the T-nuts facilitate assembly at the field.

• **Tail surfaces.** The stabilizer and fin are flat surfaces that have 1⁄16-inch balsa sheeting bonded with rubber cement to 1⁄4-inch foam-cores. Trim the surfaces to the outlines shown, and add the 3⁄8-inch balsa stock used for the LE. Use soft balsa for the elevators and rudder, and sand them to shape. To minimize weight, the wood for these large areas must be



This photo shows the tail volume, which ensures smooth flight characteristics. The prototype model is in the background.





selected carefully. Do not bevel the LE if you use Klett* or Du-Bro* hinges; with these hinges, elevator displacement is approximately 25 degrees, which is more than required.

• **Controls.** Conventional, 1⁄4-inch-diameter, wooden-dowel pushrods have been satisfactory. For maximum stiffness, keep the coupling wires as short as possible. You may prefer a pull/pull cable system for the rudder, but you should consider using a pulley wheel at the servo to avoid wearing the servo output bearing.

• **Covering and finish.** Heat-shrink plastic covering films allow us to produce highly visible, appealing color schemes. I covered the prototype with silk span and colored dope, which I airbrushed on for a light finish. This method is temperature stable and adds very little weight—about 0.2 ounce per square foot of surface.

ENGINE SYSTEM

For this project, I used a Webra* Speed 1.20, which has proven to be very user friendly. The engine starts easily with just a manual flip of the spinner; there's no need for an electric starter. Ten-percent-nitro fuel and a 16x8 APC* prop provide approximately 190 ounces of static thrust. With a gross weight of only 160 ounces, a vertical acceleration of 0.2G is anticipated. With the Davis Model Products* Pitts-style muffler strap installed,

the engine's noise level was approximat 94db (at 3 meters).

Become familiar with the engine's ru ning characteristics; set the top rpm, a then adjust idle to ensure consistent accel ation and reliable idle rpm. Don't risk engine-out situation on the initial fligl When you're satisfied with the engine s tings, conduct radio-range checks with a *without the engine running.*

FLYING

Balance the aircraft at the position shown the plan, and set the control displacemen aileron and elevators to the values note These throws are the recommended *init* settings; after that, use the settings you pref

Taxiing, acceleration and liftoff are ea to accomplish; low-rate rudder helps to mi imize abrupt directional changes duri acceleration for takeoff. In flight, rudd response is strong and noticeable; dual r is helpful and should be used when requir for any maneuver. Elevator response is n mal, but aileron roll rate is impressi because of the lower inertia moment abo the longitudinal axis. I tried differential the ailerons, but found it unnecessary.

When you're ready for knife-ed maneuvers, feed in the ailerons first and f low with rudder as needed. When t ailerons and rudder are applied sequential the entry remains axial; apply them simult neously, and the entry becomes more like barrel roll, and degrades the rest of t maneuver. For insights into control inpu for the knife-edge loop, study Figure Consider the forces involved as the aircr changes angular positions while it climbs.

You'll soon appreciate the plane's pr peller thrust and low flying weight. On t rear of the loop, air speed helps to genera the lifting forces required to level out. Practi this maneuver with adequate altitude margin

Landing characteristics are excellent; t higher drag of the configuration results in steeper descent angle and the low wi loading yields a relaxing touchdown spee The result is a shorter landing distance- helpful for smaller flying areas.

My list of follow-up things to try with t Huskie includes adding aerodynamic fai ings to the cabane struts, wheel pants, tryi various interplane strut shapes and a smo system. But flying the bipe has been enjoyable that I've been reluctant "ground" it to make these modificatio (and add the weight!). If you appreciate t challenge of precision aerobatics, this fun tional design and its favorable flying qua ties can be fun. Remember, keep it light!

**Addresses are listed alphabetically in the Index of Manufacturers on page 130.*

HOW TO

Simple steps for adding Robart Custom Struts to your next project.

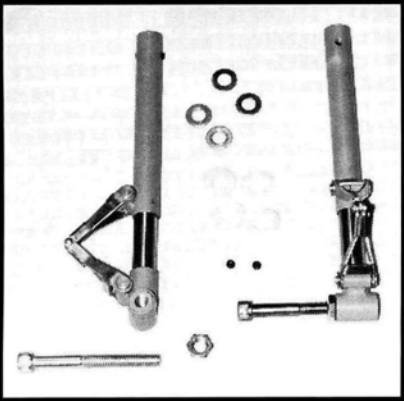
PHOTOS BY GERRY YARRISH

THE NEXT BEST thing to having a model with retracts is having one with functional Oleo-strut landing gear. The shock-absorbing abilities of these struts improve landings immensely, and the improvement in scale appearance is unquestionable.

INSTALL SHOCK-ABSORBING Oleo Landing Gear

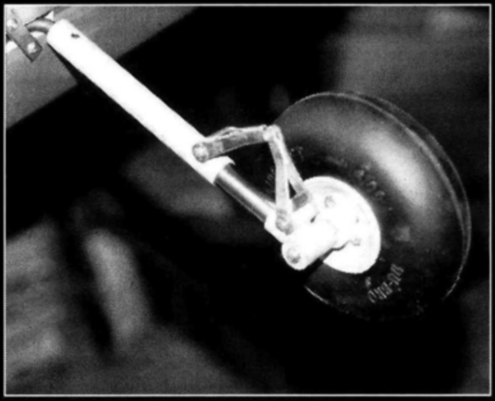
by GERRY YARRISH

Robart Mfg.* has been making Robo Struts, retracts and custom struts for more than 15 years. When I was building my latest model—the Ohio R/C Chipmunk—I wanted scale, functional landing gear that would slip over the wire gear that I had already installed in my wing. Here's how to install custom struts on your next project.

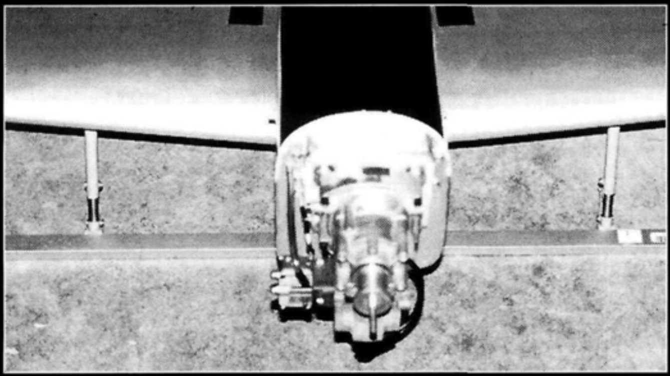


1 Before you begin, you must determine the distance between the bottom of the wing and the axle and also the diameter of the landing-gear wire to which the struts are attached. The landing-gear wire on my Ohio R/C Chipmunk is ¼ inch.

2 Clamp the landing-gear wire in a bench vise. Measure down the landing gear wire, and mark off a length of about 1 inch. Cut the wire with a cut-off wheel chucked in a Dremel Moto-Tool. Don't forget to wear safety glasses!*

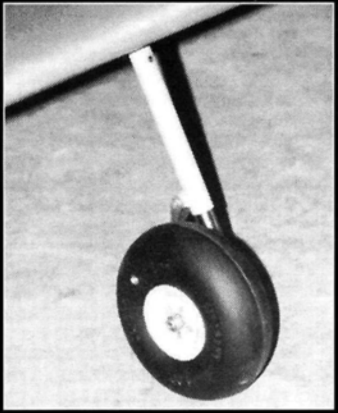


3 Slip the struts over the landing-gear wire, and snug the setscrews that hold them on the wire gear. Don't tighten them yet.



4 Remove the wheels and the axles from the struts, and place the aircraft so that the struts are on a flat surface. Use a long, straight, aluminum L-angle to align the lower struts' axle fittings with each other. Now twist each strut inward slightly to achieve approximately 1 to 1.5 degrees of toe-in for each axle. This greatly improves ground handling by reducing your model's tendency to ground loop. Now tighten the four setscrews at the top of the struts.

5 Remove the struts, and grind four flat spots about 3/16-inch wide where the setscrews have made indentations on the wire.



6 Reinstall the struts, check their alignment and toe-in adjustments again, and tighten the setscrews but, this time, add blue Loctite. Tighten the setscrews firmly, and check the axle alignment once more.*

Put the wheels onto the axle bolts, slip a Du-Bro* nylon washer on, and thread on the thin-profile locknut. Add Zap* Z-42 Thread Locker to the axle bolt, and screw it into the strut's axle fitting. When you have about 1/32 inch of clearance between the bolt head and the wheel, tighten the locknut while holding the axle bolt with an Allen wrench so that it doesn't rotate. When the Thread Locker is dry and the landing-gear wire is secured to the wing, you're ready for some improved ground handling. Custom struts look great and are easy to install.

**Addresses are listed alphabetically in the Index of Manufacturers on page 130.* ■

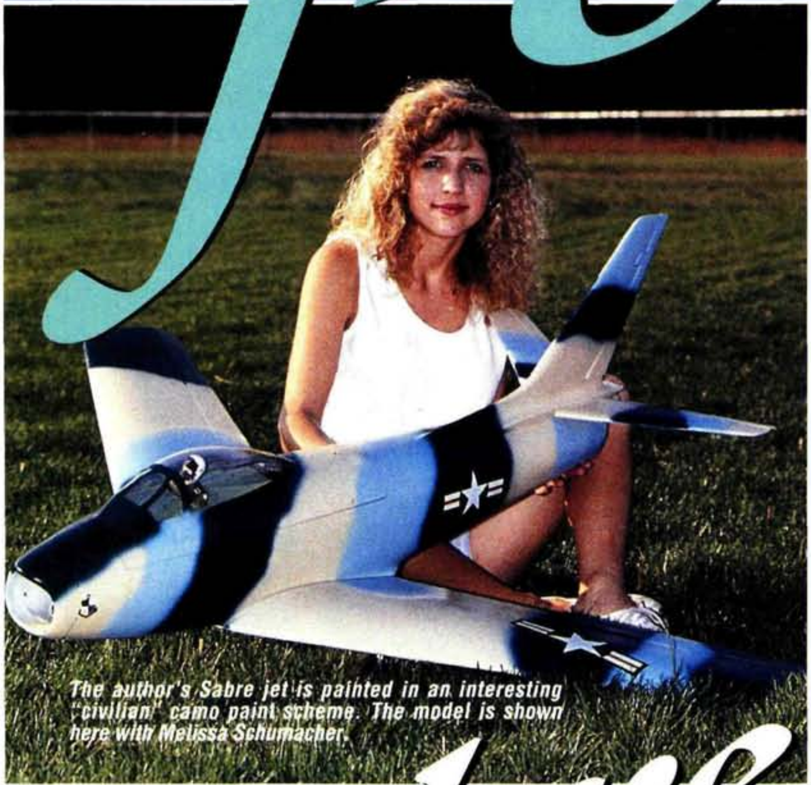
FIELD & BENCH REVIEW

A scale ducted fan that can be used as a jet trainer, yet can fly up a storm

Jet Hangar Hobbies

f-86 Sabre Jet

by DAVE WINDOM



The author's Sabre jet is painted in an interesting "civilian" camo paint scheme. The model is shown here with Melissa Schumacher.

OVER THE PAST few years, I've flown everything from trainers and twins, to electric schoolyard scale and ⅓-scale gas burners, and I've enjoyed them all. This year, I decided to try my hand at ducted-fan flying. I called some local flier friends, but none of them had experience with ducted fans. It looked as though I'd be breaking into a new technology for all of us.

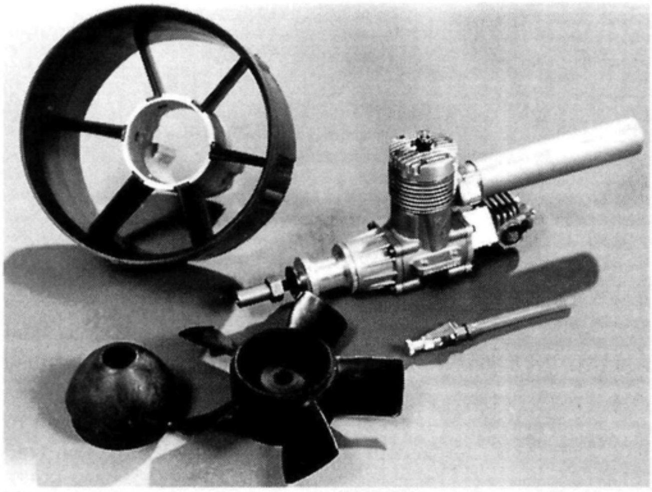
I decided to enter the "jet age" in much the same way as the U.S. Air Force did back in the '50s—with the F-86 Sabre. I ordered the F-86 kit from Jet Hangar Hobbies* (JHH) because it had recently been reworked and reintroduced. The kit would be a prototype at a reasonable price.

THE KIT

The kit arrived in a very large box that was jampacked with all the needed goodies. I ordered the complete kit package, which comes with the fiberglass fuselage, foam wings, exhaust liner, fan unit (Turbax I), a K&B 7.5cc fan engine and retracts. The plans show all of the parts and include options for building the Navy version of the plane: the FJ-3 Fury.

For three nights, I sat down with the instructions and plans and studied them until I was completely satisfied that I knew exactly what was going on. I sincerely recommend that anybody who builds the F-86 do this, as the plans contain a lot of information, and it takes some time to absorb it all.

On this kit, all the hard work has been done for the builder at the factory; for example, the hatch and nose piece come as separate parts and need only minor finish work.



The complete package includes the K&B 7.5cc engine and the Turbax I fan unit. Note the remote needle-valve assembly I also used.

While I was studying the plans, I also called Larry Wolfe at JHH and asked if an accessory kit was available. JHH supports its product line by carrying all the accessories you need to complete its kits. In no time at all, I received another box with every last part—including hinges, sheeting and glue—needed to complete the F-86 as shown in the plans. All the parts came conveniently bagged and tagged. I highly recommend that you buy the accessory kit; it saved me a great deal of time.

TAIL FEATHERS

First, I built the tail feathers, which in this case, consist of a sandwiched, center layer of fiberglass cloth with balsa laminated to either side, and an outer layer of glass cloth. I laminated the balsa to the center piece of cloth, tack-glued the plywood tip and root templates into place and then carved and sanded the balsa to the template outlines. Here's a hot "tech tip" that helped: before I glued the templates onto the balsa, I marked along the outside edge with a magic marker. When this marked edge was sanded away during the shaping process, I knew I had sanded just deep enough.

When the tail feathers had taken shape, I cut out the elevators and rudder, final-shaped and sanded them, and covered them with 3/4-ounce glass cloth. This yielded very stiff and accurate empennage pieces that were ready to be joined to the fuselage. Here's the only tricky construction step: because the F-86 has sweep and dihedral in the horizontal stabilizer, a Y-yoke, actuated by a single pushrod, is needed to operate it. There was surprisingly little room above the horizontal stab and the fuse top to get all the linkages to work properly. It can be done, but I found out the hard way that the builder must follow the dimensions and angles given in the plans *exactly*.

FUSELAGE

Building the fuselage was quick and easy since it mainly involved assembling sub-assemblies and adding them to the fuse. The old F-86 kit required that the builder cut out the hatch and nose and then construct hatch guides, etc. But on this kit, all the hard work has been done for the builder at the factory; for example, the hatch and nose piece come as separate parts and need only minor finish work.

I assembled the engine, fan unit and exhaust duct and then slid them into the fuse as a single unit. I bolted this unit to plywood mounts that had been epoxied to the fuse sides. With the power unit in place, it became a simple matter of adding fuel tanks, radio gear and the air tank to the fuse sides, just forward of the fan unit.

The canopy is glued into the top hatch, which is then fit onto the fuselage. In the front, the hatch and canopy assembly is held in place by two pins that are similar to those used on the leading edge of the wing. The trailing edge of the assembly is held by a strong latch that is easy to operate. This is important because the hatch must be removed to start the engine. I mounted all my switches, charging jacks and the air-filler fitting inside the fuse because of this easy access.

The nose gear rotates 90 degrees as it retracts, so the Rhom Air retracts had to be modified. All the instructions and the required parts are included in the kit. When the retracts had been installed (and the location of the striker plate had been fine-tuned) they worked flawlessly. I installed the nose gear, epoxied the nose piece into place and used a little filler and sanding to prep the fuse for primer.

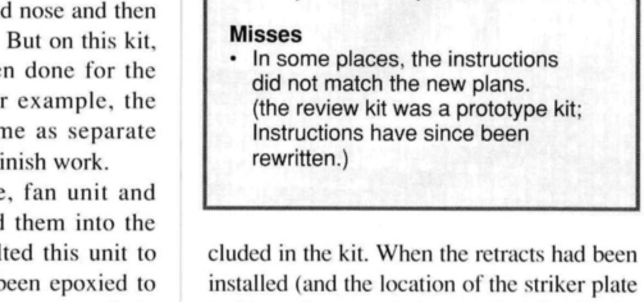
When I ordered the F-86, I had a choice of either a flat-bottom "trainer" wing or a semisymmetrical "scale" wing. I ordered both. The trainer wing seems to fly more slowly, take off somewhat more quickly and float a surprisingly long way down the runway on landing.

SPECIFICATIONS

Model name: F-86 Sabre
Type: scale ducted-fan trainer
Manufacturer: Jet Hangar Hobbies
Weight: 8½ lb.
Wingspan: 50½ in.
Wing area: 555 sq. in.
Length: 50½ in.
Power required: .45ci to .82ci ducted-fan engine
No. of channels req'd: 5 (aileron, throttle, elevator, retracts, rudder. Flaps are optional.)
Radio used: Hitec/RCD* 7-channel
Kit construction: fiberglass fuse, balsa-sheeted foam flying surfaces
List price: $400; $850 (special package).

Hits
- Easy assembly.
- Excellent product support.
- Mild to wild flight-performance range.
- Many available options.

Misses
- In some places, the instructions did not match the new plans. (the review kit was a prototype kit; Instructions have since been rewritten.)



Access to the interior is fast and uncomplicated. The canopy/hatch is removed for access to the radio as well as to the engine for starting.

FLIGHT PERFORMANCE

I took the Sabre to the Coeur D Alene Area Modeler Society field over in Post Falls, ID; it has a nice, long, paved runway. The Sabre covered a lot of runway before it became airborne. A quick test flight to check the trims, and then I set up for landing. On touchdown, the mains toed-in and brought the Sabre to a rather quick halt.

After these attempts, I talked to Larry Wolfe at JHH and then made the following changes: lengthened the nose strut to get a positive angle of attack, added JHH main-gear struts, increased elevator throw and made sure that the main gear tracked true. These changes made the next flights quite successful.

• Takeoff and landing

I found that a ducted fan just won't rotate until it has sufficient speed, and then it's not hard at all; just hold back pressure when the nose gets light and fly it off. The Sabre tracks well, but because of its somewhat narrow gear stance, it tends to have sensitive steering. I reduced the servo throw, and the steering smoothed out on subsequent takeoffs. The Sabre accelerates well, and when it's airborne with the gear up, it really moves out.

I set up for landings quite a way out and hold 1/4 to 1/2 throttle. Once I'm lined up, I pull the throttle back to high idle until the model is settling toward the runway. I then pull the power all the way back. I've found that this takes a little finesse because the Sabre can fool you and float farther than expected. I've also found that during an approach, I have to keep in mind that there is a lag between advancing the throttle and the power actually coming on. There's no instant power like with a prop plane, but there's also no torque reaction, and that's nice.

• High-speed performance

This is what the F-86 does well. It isn't super-fast (I estimate that speeds range from 100 to 110mph), and I fly it at perhaps 80-percent throttle for nice, scale-like flybys. But it really flies rock-solid, somewhat like a Big Stik or a Hots. At high speeds, it's responsive, but not twitchy, and hard turns show no tendency to snap; in fact, it can be forced to skid until the thrust catches up with it, and then it's off in a new direction. The Sabre is truly a ducted-fan trainer and can easily be flown by those with only moderate piloting skills. If you can handle a pattern-type airplane, you can handle the F-86.

• Low-speed performance

Because of the swept wings, I was somewhat worried about low speeds, but the F-86 is really quite tame. Stalls break cleanly and straight ahead, and though recovery takes some room, it's not bad at all. The Sabre will float quite a long way especially with the trainer wing in ground-effect.

• Aerobatics

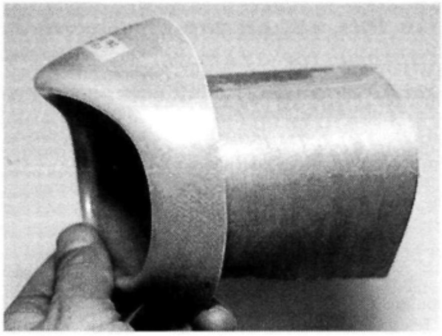
The Sabre has pretty good vertical performance, but I prefer to fly it in roller coaster fashion. It rolls beautifully owing to its lack of torque, and its loops are large and round. If rudder (optional) is built-in, the Sabre knife-edges easily. With the throw on low rate, it's quite docile; on high rate, it can get pretty wild and crazy. Inverted flight presents no problem for either wing, although the flat-bottom wing seemed to require just a touch more down-pressure. My favorite maneuver is a hair-raising low pass. Here's how it's done: gear up whistling down the runway, pull up to a victory roll, drop the gear, enter the pattern and land.

WING

The wing is a three-section foam-core with balsa sheeting and glass covering. I added optional flaps that are activated by mini-servos to the scale wing, but not to the trainer wing.

Building the wings requires that you cut grooves in the foam-cores. The aileron and retract outer Nyrods fit into these grooves before the wing is sheeted. To remove the foam, I used scrap pieces of 12-gauge soft-copper wire inserted into a soldering gun. I also installed the air lines and retract mounting plates before I sheeted the cores with the Dave Brown sorghum that's included with the accessory kit; it worked quite well.

I then sanded the wing's outer panels to the proper dihedral angle and joined them to the center section. After setting the wing aside overnight, I cut a slot in its bottom for the dihedral brace—again using the soldering-gun tool. I then epoxied the



The fuselage nose piece is molded separately. Here, I'm test-fitting the inlet tube to the nose.

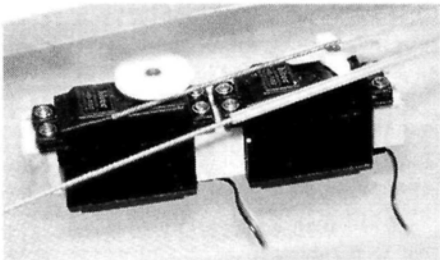
dihedral brace into place.

Once I had sanded the wing to its final shape, I mated it to the fuse. The fan shroud protrudes downward slightly from the fuselage, so the wing had to be relieved to accept the fuselage. I carefully removed material from the wing and kept test-fitting until the wing matched the fuselage, taking into account the thickness of the fiberglass cloth that would later be added to the wing center section. With the wing mounted, I started to cut out the ailerons, mount the retracts and cover the wing with lightweight glass cloth. Here's another hot tech tip: I laminated 1/64-inch-thick plywood to the trailing edge of the wings and inserted it into the tips and trailing edges of the rudder and elevators along the center line. All I then had to do was sand down to the plywood to achieve a very sharp, straight trailing edge. The results look very professional.

PAINTING AND FINISHING

The JHH fuselage is of very high quality, so pinholes are not a big problem. But to fill the few that I found, I primed the Sabre with K200 (an automotive primer) and wearing a rubber glove, I wiped my hand across the still-wet primer—no more pinholes! I then wet-sanded the fuselage, shot another coat of primer on and wet-sanded again.

Before I started this project, I called Bob Banka's Scale Model Research* and asked for three color schemes that would be different from the traditional all-

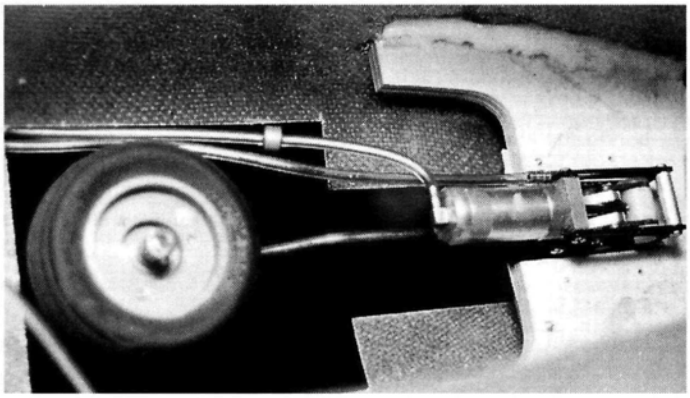


The rudder and elevator servos are mounted on a plywood plate that is epoxied into place on the forward fuselage side.

aluminum Korean War-vintage Sabres. I finally chose a civilian-owned Sabre with a pretty hot camo paint job—a very visible scheme.

I used Duracryl automotive acrylic lacquer paint because it is very forgiving. It flash-dries quickly, and if I make a mistake, I wait a few minutes then spray again, and the new coat melts into the old. It can be custom-mixed at almost any auto-parts store and is relatively inexpensive.

One of the nice things about this JHH Sabre is that detailing is left entirely to the builder. This was my first attempt at a ducted fan, so I kept my detailing simple and light. Also, many options can be added, from operational speed brakes to drop tanks, and its outline is to scale. The scale struts sold by JHH are a must-have option. Another nice thing about JHH was the technical support and advice I received. Whenever I had questions, help was just a phone call away. The kit had brand-new drawings, so the instructions didn't always match, but JHH always had the answer. (Note: the instructions are being rewritten and should be complete by the time this review is published.)

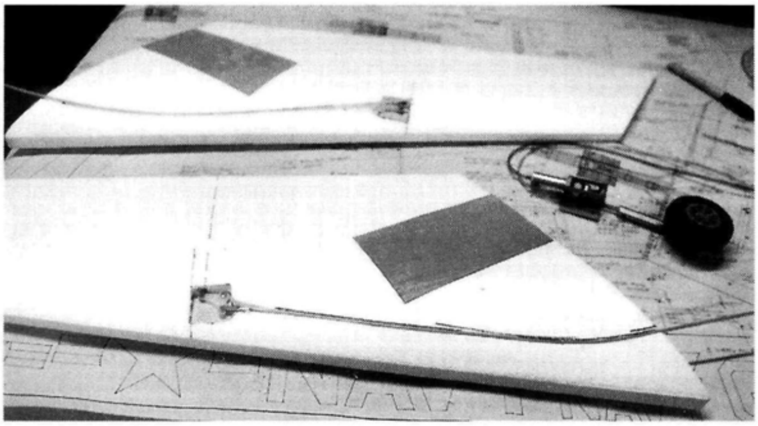


The nose-gear retract unit in place on the plywood mount.

With the final assembly complete, I set up the tuned pipe according to the plans. It had been a long time since I had an engine that ran as well right out of the box as the K&B 7.5 did. After break-in, the engine easily tached 23,600rpm and never skipped a beat. Even during a number of flights, the engine has never flamed out in the air, and it seems to be fairly easy on the glow plugs.

I've never had as much fun building a model as I had with this one. Everything seemed to go smoothly from the very start, and each night, I left my workshop smiling. The quality of the kit is good, and the wood is exceptional. There are plenty of high-tech construction aspects that keep it interesting and enough balsa carving and sanding to keep the workshop smelling good.

The product was well-backed by the manufacturer, who was always available to help. The Sabre looks as good on the ground as it does in the air. Except for some problems in the initial setup, I had no problems with its flight characteristics. I know this sounds too good to be true, but I'm very pleased. I initially approached this project with some trepidation; after all, I had never worked with ducted fans before. But I found that there's no voodoo involved—only straightforward modeling.



The secret to successful wing construction is to carefully transfer the dimensions from the plans to the wing-cores.

** Addresses are listed alphabetically in the Index of Manufacturers on page 130.* ■

HOW TO

by GEORGE LEU

THE BOMB

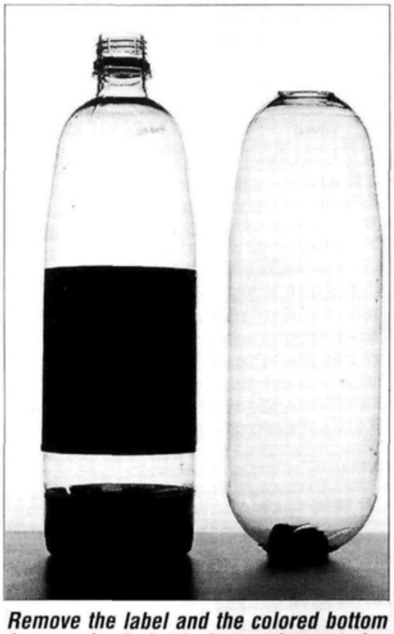
Glue on a Vortac* or Hobby Lobby* bomb drop, and you're ready to dive-bomb your local flying field.

The Douglas Dauntless dive bomber is one of many aircraft that doesn't look right without a bomb slung under its belly.

PHOTOS BY WALTER SIDAS

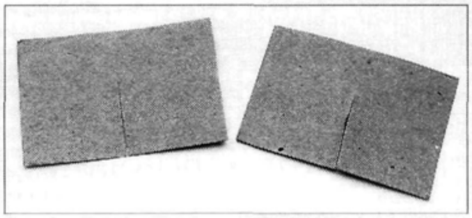
Recycle plastic soda bottles into wing-mounted ordnance

I started this project on a whim when I missed the recycling pickup. I didn't want to take my plastic soda bottles to the recycling center, and I didn't want to keep them for another month, so I decided to do something with them. Here's how I created "The Bomb."

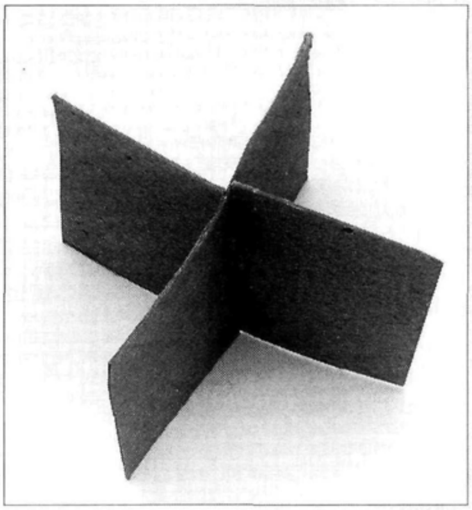


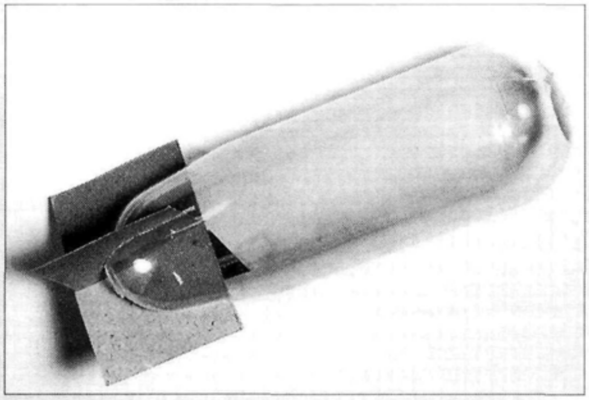
Remove the label and the colored bottom from a plastic bottle by running very hot water over them. The hot water will soften the glue and allow you to remove both.

Use a band saw to cut the neck off the bottle and to make two 2-inch-deep perpendicular cuts in the bottle. Hold the bottle firmly as you cut; otherwise, it will vibrate too much.



Cut out two 4x4-inch pieces of cardboard; these will become the bomb fins. Slit each piece down the middle; then push one piece into the other. Insert this assembly into the 2-inch-deep perpendicular cuts that are in the rear of the bottle.

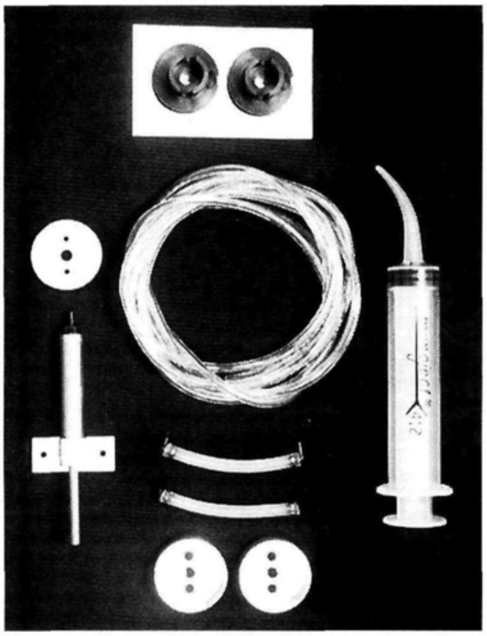




To prevent the fins from moving, add a seam of white glue where they touch the bottle. Let the glue dry, and spray paint the bomb flat black.

Now you're ready to create havoc at the flying field! I added some yellow pinstriping for scale effect and to help dress up the bomb. Most modelers I meet have a difficult time believing that my bomb is an inexpensive, recycled-plastic, homemade device. Try one; I'm sure you'll like it.

*Addresses are listed alphabetically in the Index of Manufacturers on page 130. ■



FIORENZE Brake System

by RICH URAVITCH

Stopping power with R/C hydraulics

IT HAS ALWAYS been interesting to me just how far we, as R/C modelers, will go to simulate, if not duplicate, all the features found in full-scale airplanes. The quest is most notable in the world of scale modeling where the objective *is* to produce a miniature version of a specific airplane.

The models at such prestigious scale events as Top Gun and the Scale Masters are all built with the same idea in mind: to produce a miniature that's as accurate as possible. In addition to the more obvious surface detailing, cockpit work and color schemes, operating features such as flaps, retracts and stores-release systems, speed brakes and other prototypical mechanisms are now incorporated almost routinely. Some of the newest generation of commercially available kits even include the instructions and the parts to build some of these features into your model.

The supplied drill jig allows accurately positioned holes to be drilled in the wheel hub. Be sure there's no slop between the axle and hub. This will ensure that the drill jig is perfectly centered on the wheel.

Reliable retract systems have been around for years, and they continue to improve because the manufacturers have at last recognized that *one size truly doesn't fit all!* Complete systems for getting the wheels into the wells are available for nearly any model. Ditto for all those neat operating features I mentioned earlier.

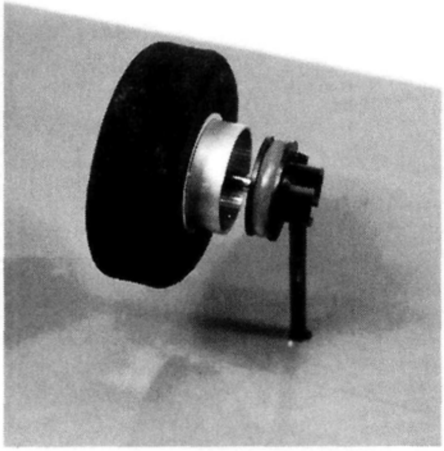
STOPPING POWER

What *hasn't* been available, until now, is a reliable, relatively inexpensive wheel-brake system that can be installed on almost any R/C scale *or* sport model. Yes, I know, there have been "friction on the tire"-type systems in the past—some available commercially, others home-built; all worked with various degrees of effectiveness and reliability. We now have an honest-to-goodness, drum-type braking system that is *hydraulically* actuated; and not only can it be adapted to a new model, but it can easily be retrofitted to a model that's already built! Pretty neat, huh? And it's available *now!*

The brake drum is attached to the wheel with two 2-56 countersunk screws. It's essential to center the drum on the hub.

The system was conceived, designed and developed by Bob Fiorenze*, who now markets it. He's the guy who opened up the modeling world's eyes to scale ducted-fan models with his black "Playboy Bunny" F-4 Phantom and F-14 Tomcat beauties. You can always find him on the competition circuit—usually at, or near, the top of the scoreboard.

I borrowed the model I chose as the test bed for the braking system from my buddy Nick Ziroli. It's his prototype Pazmany PL-1—a scale model he designed and published 20 years ago in *American Aircraft Modeler* magazine (and I thought *I* kept airplanes around for a long time!). I felt that Nick's plane is typical of the average sport-scale model: .46-powered; simple, $\frac{5}{32}$-inch music-wire landing gear; $6\frac{1}{2}$ pounds; MonoKote* covered; 5 channels—the usual stuff! The biggest plus, however, was that it was available!



The tire/brake drum assembly is about to be slid over the hub and brake lining. The setscrew that secures the hub to the gear strut is underneath the lining. Don't forget to tighten it!

SYSTEM DESCRIPTION

The system is supplied as shown in the photo, and it weighs less than 1.5 ounces installed. It consists of two injection-molded hubs and assorted fittings; two machined drums and a fixture for drilling the wheel-hub; a master cylinder; a 5-foot length of clear "hydraulic" line; a pair of brake "linings"; and a filling syringe. The illustrated instructions are somewhat vague in a few areas, and there are some omissions, but you'll easily figure them out as you proceed with the installation. The instructions are now being revised to eliminate the chance of confusion. In any event, the only thing you'll lose is a little time spent on figuring things out.

INSTALLATION

Installation is not really complicated and will, undoubtedly, become easier with the revised and refined instructions. Key points:

• The machined metal drums (part no. 410) must be *absolutely* centered on the wheel to avoid chaffing the plastic brake hubs (no. 405). If the hub-drilling fixture (no. 465) has any slop in it, eliminate it before you drill the drum attachment-screw holes.

• Wheels with relatively flat hubs, such as those by Dave Brown or Kraft, will allow a very easy attachment of the drum. The "spoked" hubs of the Du-Bro-type wheels may make it a little more difficult to attach the drum.

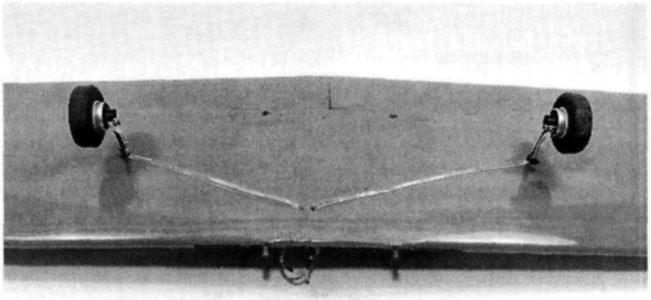
• Remember to tighten the setscrew that's in the plastic hub. This will secure the hub to the axle. Do this *before* you install the brake lining.

When the drums have been attached to the wheels, with the hubs secured to the axles, and you're sure that the wheel/drum assembly rotates freely without drag, you can install the master cylinder and the brake-line tubing. A standard servo (40 oz.-in. of torque) plugged into an auxiliary channel will work well. A "mini" servo or a servo with less torque probably wouldn't provide enough power for full brake application.

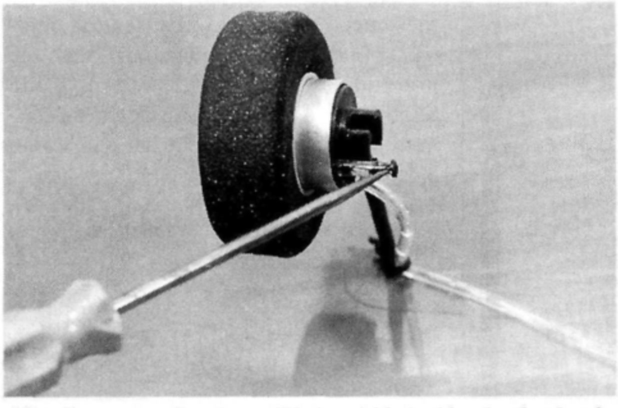
The instructions suggest that the "down"-side throw of the elevator servo be used to actuate the master cylinder. Bear in mind that using this hook-up method requires that your model have its landing gear mounted in the fuselage rather than in the wing. For *any* installation, however, the actuating servo, master cylinder and landing gear should be mounted in the same airframe component—either the wing or the fuselage. The reason is simple. It would be impossible to remove the wing from the fuselage to transport the plane without also having some way to disconnect the brake lines. Using quick-disconnects would work, but they are potential sources of fluid and pressure losses and probably should be avoided. In addition, you'd have to fill and bleed the system every time you attached the wing to the fuselage. For low-wing, tricycle-gear-equipped models (with removable wings), I suggest that you consider the installation shown here in the Pazmany.

The installation took two hours plus a little time for bleeding and adjusting the brakes. The hydraulic medium used to charge the system is a molecular mixture of hydrogen and oxygen; it's available everywhere and it's inexpensive. It's water! Yup; plain ole water! Why use oil or any other sloppy stuff when aqua works? Does this mean I'll have to add antifreeze for winter flying here in the North?

Because the hubs took up some space on the axles, I had to replace the Pazmany's original wheel collars with soldered washers. Keep this in mind when you install your system; make sure the axle is long enough to accept the hub, wheel/drum assembly and wheel-retention device. If it isn't, you may have to bend up some new 5/32 wire gear struts.



For simplicity, the brake-line tubing on the test installation was mounted on the outside of the wing's lower surface. It goes through the wing and is connected to the master cylinder.



PHOTOS BY RICH URAVITCH

After the system has been filled and bled, this plastic plug is inserted into the line. Be careful when you remove it because you could break the barbed hub fitting. The newest version of the system has a screw-type bleed port, so the potential problem has been eliminated.

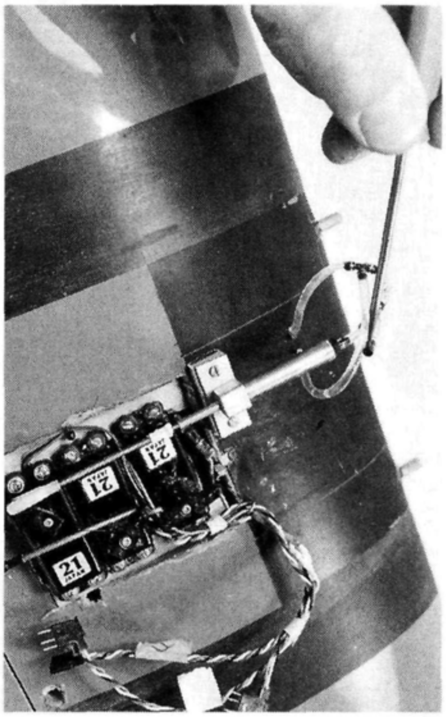
DOES THE SYSTEM WORK?

In two words: you bet! It's pretty neat to taxi the Pazmany to the edge of the runway, set the brakes, run the engine up to "check the mag drop," come off the power, release the brakes and take the active runway for takeoff. We're really closing in on this realism thing!

Initially, when applied gradually, the brakes seemed to make the airplane pull a bit to the right. With use, this condition improved and has now completely disappeared. I recommend that you use an auxiliary channel to control the brakes and that the channel used be actuated by a variable pot (round knob or linear slide) so that you'll be able to control brake application more accurately. Using an on/off-type-switch-controlled channel will make the brakes essentially non-variable.

Since I received, installed and used my system, Bob has refined the instructions and has upgraded the system to include a miniature bleeder valve at each wheel-hub end.

FIORENZE BRAKE SYSTEM



The pointer shows the plug that's removed from the brake line when the system is first filled with water. To ensure maximum braking effect, all the lines should be filled with water, and there shouldn't be any visible air bubbles.

This eliminates the need to completely remove the original plugs (non-bleeder type) from the ends of the lines to facilitate the occasional required bleeding. Because of this, the original plugs had a greater potential for breaking or being lost. Although I haven't had any difficulties with my originally configured system, Bob's incorporation of this refinement seems to make a lot of sense and speaks well for his concern for the user.

Will I get another set? Absolutely! I can just see my 12-pound, ducted-fan F-80 idling at the end of the runway. I set the brakes and spool up to a cloud of smoke and castor fumes as the big O.S. comes on the pipe; brake release causes the compressed nose strut to unload and pitch the nose up slightly and, suddenly, the Shooting Star is rocketing down the tarmac! Miller time doesn't even come close....

**Addresses are listed alphabetically in the Index of Manufacturers on page 130 .* ■

HOW TO

by CARL RISTEEN **PART 2**

Improving Flight Performance

Banishing the fog around lateral controllability and stability

PART 1 of this series covered the root cause (aileron-induced drag) of adverse yaw and various well-proven schemes to combat it and beef up lateral control. This part covers the pivotal role that lateral forces can play in helping handling, stability and knife-edge.

THE UNNATURAL VERTICAL TAIL—FRONTLINE YAW FIGHTER

When a model snap-rolls inverted and re-kits itself, there is a reason. Since the dawn of human flight, airplane people have been battling the same unforgiving dynamics that assaulted your model that other weekend.

The Wright brothers' wing-warping lateral control paved the way to powered flight. It also opened a yawning pothole: warp drag. Their wing-warp-controlled, un-dihedralled glider seemed determined to auger into the ground following anything more daring than the most gentle of turns (Wilbur called it "well digging"). He had borrowed the wing-warping idea from buzzards, but nobody had ever seen a buzzard do anything like that.

Had the far-seeing Wilbur been a more eagle-eyed buzzard gazer, he would have noticed the feathered soarers tilting their tails upon entering tight turns. The tilted tail very efficiently supplies the anti-yaw force needed to resist the unbalanced wing drag that warping causes. Tail tilt is called up only when the anti-yaw force is needed. This crafty trick enables the same surface to pinch-hit as vertical tail area, in addition to its regular job as horizontal tail, thus reducing drag.

Undaunted, Wilbur soon deduced the cause of the problem. His practical solution was a device that carries on virtually unchanged today—the vertical tail. The vertical tail does cost weight and drag. Repayment is greatest when an airplane is entering a turn or verging on stall. Tail tilting is more efficient at supplying a combination of horizontal and vertical stabilizing forces, but it is much better suited to a bird's super-sensitive control system than to an airplane's. Fixed tail tilting has been used by free-flight modelers for decades for trimming the flight pattern. More recently, lateral control by tail tilting saved precious weight and cut drag in the first truly successful human-powered airplanes. The V-tail is sort of a compromise between a tilting tail and a conventional tail assembly. It needs considerably less total area and thus cuts drag; but various peculiarities limit its appeal.

A 48-inch-span sport fun-fly bipe.

Early designers seemed to have argued: since birds manage just fine without vertical tails, why burden an airplane with more than the absolute minimum of such a seemingly superfluous appendage? They proceeded to adorn WW I fighters' posteriors with tiny vertical tails that probably helped spiral stability but almost certainly contributed to the horrendous stall/spin accident toll.

But the vertical tail can't do the job all by itself. A thoughtful designer pays as much attention to lateral area and its distribution as to the horizontal wing and tail areas that lift his creation and stabilize it in pitch. Hyper-powered, competition free-flight models currently perch at the zenith of design balance of lateral area, dihedral, incidence, thrust line and other factors in the quest for self-righting natural stability that would astound most full-scale "experts." For decades, lateral area distribution in free-flight models has been the subject of experimentation and wrangling (see Andy Lennon's articles in January and July 1994 *Model Airplane News*). Freed of all controllability concern, the free-flight designer can focus intensely on lateral stability and aerodynamic efficiency. Designers of R/C trainers are forced to compromise and strive for a balance between stability and controllability—by nature, reluctant bedfellows.

DIHEDRAL—A TWO-EDGED SWORD (FIGURE 1)

Dihedral supplies lateral stability like nothing else, but it extracts a heavy price in controllability. Very generous dihedral is a do-or-die necessity in a competition free-flight power model. A more sedate R/C primary trainer also needs a reasonable amount to give it strong self-righting lateral stability without unduly compromising its aileron effectiveness. Reducing the dihedral of many aileron-equipped trainers improves lateral controllability and inverted flight—a modification that pleases most fliers who have survived their knee-knocking primary training phase and can bear giving up a little spiral stability.

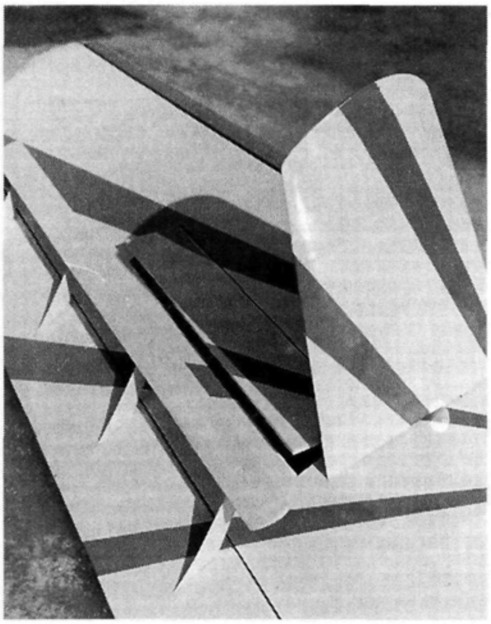
A model with a lot of dihedral has a strong tendency to roll with rudder deflection (in the same direction that the rudder is moved). This is called proverse yaw/roll coupling, and it is essential in non-aileron models for lateral control solely by the rudder. When the wings have been knocked

PHOTOS BY CARL RISTEEN

into a bank by turbulent air, gravity tends to sideslip the model toward the low wing. The dihedralled wing responds by producing a rolling moment in the opposite direction. This tends to right the model and return the new flier's heartbeat to a rate less than that of a mortally challenged chipmunk. Proverse yaw/roll coupling also tends to incite dihedral to sabotage aileron control, since most aileron setups produce adverse yaw, which tries to make the model roll the wrong way.

The vertical tail acts like the fin on a weathercock, tending to turn the model in the direction of the sideslip. This reduces the sideslip and, in turn, renders dihedral less effective at righting the model. Dihedral can produce a corrective rolling moment only when it is assisted by sideslip. The larger the vertical tail, the stronger the weathercock effect and the less the sideslip. When the model is in a bank, it will tend to turn toward the low wing, and the nose will drop at the same time because the lift force no longer acts vertically, but is canted over along with the wing. If the model were trimmed to fly level, the vertical component of lift would be insufficient to support its weight, so the nose would drop. At the same time, the horizontal component of lift of the canted wing would force the model into a turn toward the low wing. As air speed increases due to the dive, the vertical tail develops a stronger aerodynamic force that tends to further reduce the sideslip and its wing-leveling ability. If the weathercock action is too strong, the roll angle increases further, and the nose drops a little more. The unfortunate airplane may develop a near-vertical spiral dive ending in its demise. Application of roll control against the spiral will stop it. Beginners frequently yank on full up-elevator in panic, and that only tightens the spiral.

A good primary trainer should recover from a spiral dive by itself with minimal altitude loss—thanks to ample dihedral and a lateral area size and distribution that allow the model to sideslip enough to let the dihedral do its wing-leveling thing. The trick is getting good lateral stability without killing lateral controllability.



For improved yaw resistance, here's an experimental vertical fin on the wing of an 86-inch-span experimental monoplane.

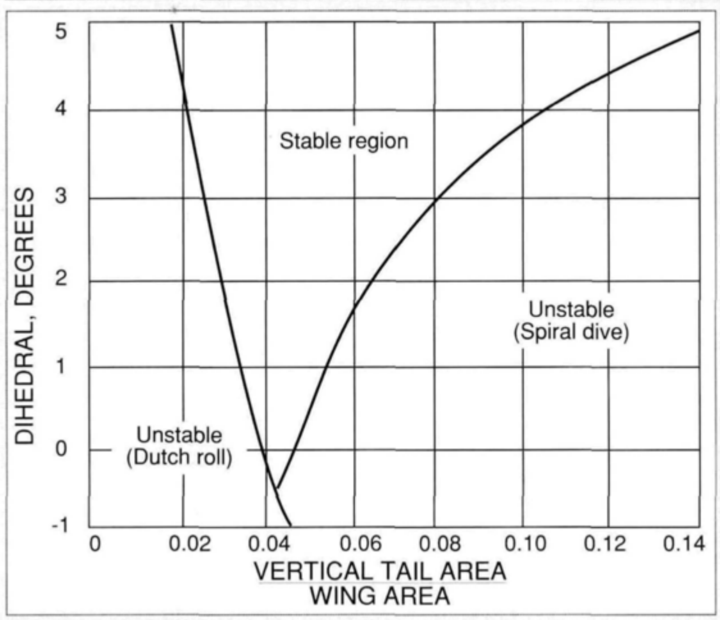


Figure 1

Dihedral and vertical tail combinations for lateral stability for a typical high-wing airplane.

This graph applies only to one setting of elevator trim and CG location for one typical fuselage design and wing planform.

It's useful as a guide only. Individual designs will vary somewhat, but the general shape of the curve will be similar. Note that the high-wing layout can use negative dihedral (anhedral) and still have some lateral stability.

For a low-wing design, the entire curve will be displaced upward by about 2 degrees, depending on the fuselage depth and shape.

DIHEDRAL AND AEROBATICS—A BALANCE ACT (FIGURE 2)

Getting the wing dihedral just right on a model intended for serious aerobatics is crucial. Too much dihedral makes the model want to roll in the direction that you move the rudder (proverse yaw/roll coupling). Too little dihedral makes the model try to roll in the opposite direction (adverse yaw/roll coupling), which is a much more unnatural-feeling characteristic. Both make the flier's job tougher by forcing him to constantly fight unwanted roll with just the right amount of aileron control input. The correct amount of dihedral is heavily influenced by the vertical position of the wing on the fuselage. Wing taper and the shape and height of the fuselage around the wing root are important. With a low-positioned wing, a deeper or boxier-section fuselage and greater wing taper all dictate an increased need for dihedral. The rudder itself generates adverse roll, since most of its surface is usually well above the horizontal drawn through the center of lateral area.

When the rudder is deflected to the right on a low-wing model, air pressure will be higher on the left fuselage side and will tend to push against the upper inner portion of the left wing. The result will be a tendency to roll to the left (or, opposite the rudder movement). This is adverse yaw/roll coupling. A little dihedral in the wing will counteract the adverse roll.

Conversely, an un-dihedralled high- or shoulder-wing model will tend to roll in the same direction as rudder deflection. A yaw to the right will tend to raise the air pressure underneath the left wing root and lower the pressure underneath the right wing root. Getting rid of this proverse yaw/roll coupling would need a little negative dihedral (anhedral). Aerodynamically, an anhedralled shoulder-wing model should be every bit as aerobatically competent as a low-wing model, but you may regard its droopy-wing look as a put-off.

VERTICAL TAIL AREA—HOW MUCH IS "RIGHT"? (FIGURE 1)

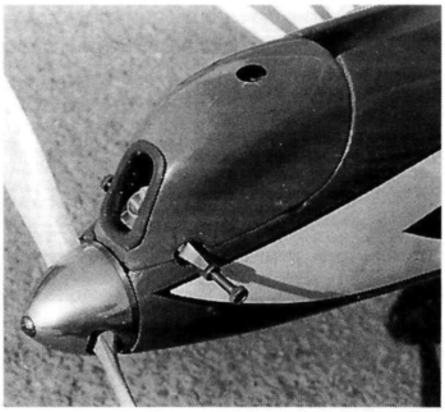
Reducing the vertical tail area helps hands-off recovery from a spiral dive, but it tends to hurt aileron effectiveness in any airplane with common proverse yaw/roll coupling.

The smaller vertical tail's weaker yaw resistance is more easily overcome by adverse aileron drag. An airplane that's a bit shy of vertical tail area may have outstanding spiral stability, but it will tend toward a behavioral glitch called Dutch roll. Named for its resemblance to a peculiar style used by Dutch skaters many years ago, Dutch roll consists of out-of-phase oscillations in roll and yaw. Old-timers may recall the amusing antics of Joe Wagner's wonderful little Dakota free-flight bipe of the 1950s that was kitted by Veco. It had loads of dihedral, a super-deep fuselage and a smallish vertical tail. If built just a little tail-heavy, it Dutch-rolled alarmingly, sometimes exceeding vertical roll angles. Amazingly, the little bird flatly refused to drop its nose, and it never crashed.

A model with poor lateral controllability does nasty things like rolling over on its back and crashing when you don't treat the sticks just right, even though it may carry on by itself just fine if you don't interfere too much. At low speed, it may behave in a very unstable manner under the influence of unwisely large aileron control input. Even experts can get into trouble with a touchy model in a gusty crosswind. A friendly, good-natured model will try its best to work with you and keep itself out of trouble.

Our ideal model flies on an even keel, even when it's forced into deep stall, at which time it should do nothing worse than mush along in a stable, nose-high attitude. Its ailerons should remain effective without rudder assistance.

The fuselage side area, particularly the portion around and ahead of the center of gravity (CG), acts in concert with the aft area of the vertical tail and fuselage to produce yaw resistance. This works in exactly the same way as the wing and horizontal tail act together to supply pitch resistance. At low air speed in a gusty wind, an airplane is under constant attack by malevolent external



A clean nose helps the fuselage to develop more lateral force when yawed and moves the center of lateral force forward, helping to hold the nose up in knife-edge. It also tends to improve overall handling and reduces turbulence over tail feathers.

forces intent on forcing it into a bad attitude. When a wind gust overcomes a model's yaw resistance and turns it about the yaw axis, the wing doesn't like it one bit and lets you know it. The leading panel, moving faster, develops more lift, causing a roll in the direction of the yaw. Dihedral adds further roll in the same direction.

The lagging panel gets a particularly bad deal. The backward movement produced by sudden yaw reduces its air speed, which reduces its lift. It may also be blanketed by turbulent air spilling off the forward part of the fuselage, reducing its lift still further and causing even more roll. The knockout punch comes when the downward-moving wing is forced into an angle of attack beyond stall. Stalled, it loses lift and gains a lot of drag, and our glass-jawed fighter goes belly-up and hits the canvas hard.

At angles of attack well below stall, a wing resists being rolled. In a roll, air flows upward as well as rearward over the downward-moving wing. This gives the wing a higher angle of attack, which tends to produce more lift, which resists the roll. This is called dynamic roll stability. As the wing approaches stall, an increased angle of attack generates less and less additional lift, and roll resistance softens. Beyond stall, lift decreases with increasing angle of attack. The downward-moving wing will develop less lift (and much more drag) than the upward-moving wing, causing the roll and yaw rates to increase. Our model is now dynamically unstable in roll. The resulting continuous roll accompanied by heavy yaw is called autorotation (a fancy term for spin). Inadvertent spin is a frequent cause of crashes, particularly during takeoff and landing. The complex dynamics of spin have induced headaches in "theory people" for decades.

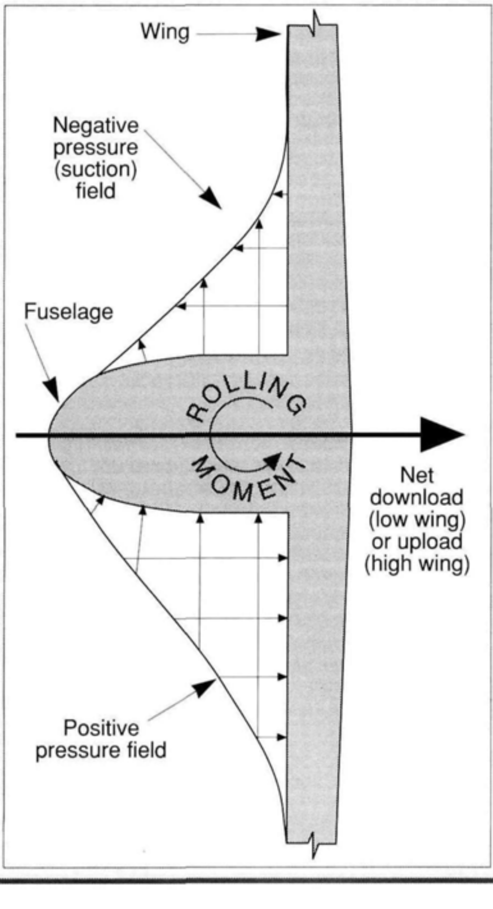


Figure 2

Fuse/wing interference and yaw/roll and yaw/pitch coupling

Illustration of approximate aerodynamic pressure at wing/fuselage intersection of a model flying in knife-edge.

Air pressure on the wing produces a CCW rolling moment. Dihedral (low wing) or anhedral (high wing) is required to resist this moment.

Depending on the nose shape, turbulence makes the negative-pressure field weaker than the positive-pressure field, particularly at large yaw angels.

A difference between positive and negative pressure exerts a net load on the wing that causes pitch down (low wing) or pitch up (high wing). A corresponding pressure field around the fuselage/tail intersection may counteract pitch up/down or may worsen it.

YAW RESISTANCE—R_X FOR AILING LATERAL CONTROL

Aircraft differ greatly in their yaw resistance, which is their ability to absorb the punch of external yawing force and come up fighting. Yaw resistance is proportional to the air speed squared, and may become critically low at near-stall air speed.

A twin-engine airplane flying on one engine needs a lot of yaw resistance to battle the yawing couple that's generated by asymmetric thrust (in addition to battling the usual aileron drag). Many do not have enough and go out of control while they are well above stall air speed. The common, light twins are frequent victims. Rather than subject you to a long calculation, I suggest you eyeball any of the current

commuter turboprop twins to get an impression of the kind of vertical tail area you need for solid engine-out control.

An airplane with a wing that tends to develop high yawing couples that's married to a fuselage and vertical tail with poor yaw resistance is headed for trouble (Figure 3). A less-than-ideal combination would be a relatively long, constant-chord wing on a short fuselage; the Piper Cub is a good example. With a lot of wing area a long way from the fuselage, a wind gust or other disturbance can develop a hefty yawing couple. Such aircraft need constant attention to the rudder to maintain control at low air speed, unless a lot of care is taken with aileron design and rigging to reduce unequal aileron drag.

At low air speed, on an airplane with strong yaw/roll coupling, ailerons tend to act more like a rudder that some brain-dead mechanic hooked up backward, and the rudder begins to act more like the ailerons; but, at least the rudder supplies roll control that doesn't reverse at inappropriate times.

Author's original 48-inch-span sport fun-fly bipe: ultra-tight turning, super-light experiment. Flies and handles well, but its very shallow fuselage hurt knife-edge. To get stronger knife-edge, the interplane struts were later changed to airfoiled, wide-chord "cheater"-type, and the cabane was covered. The bipe now does 20-foot-square knife-edge loops and tracks better in deep stall. Specifications: weight—26 ounces; Nelson* .20 with home-made ½-ounce pipe.; 768-square-inch wing; boost tabs on flaperons—same micro-servo handles coupled flap and elevator control functions; Hitec/RCD* Micro receiver; Futaba* S133 servos; wing loading under 5 ounce per square foot.

LATERAL AREA—IMPORTANT UP FRONT

Good yaw resistance boosts lateral controllability but demands lateral area up forward, not just in the vertical tail. Resisting a yaw upset requires a moment, or twisting effect about the yaw axis. This moment can only be provided by a force couple composed of two parallel forces spaced as far apart as possible. The vertical tail can provide only one member of the force pair. If an airplane had no lateral area except in the vertical tail and no dihedral, it would tend to swing its nose back and forth constantly, like a pendulum, when upset by rough air (remember the Quick-Fly Dance?). The wobbling airplane is simply using its own inertia to supply the other half of the force couple. Lateral area up forward would resist the sideways motion, acting in concert with the vertical tail.

The long-fuselage trend in pattern model design adds weight and drag but tremendously beefs up yaw resistance, tracking and overall handling sweetness. Minimally, yaw resistance is proportional to the square of the fuselage length. Keep yaw low, and you also corral yaw-induced roll. The result: an airplane that tends to stall straight ahead, making recovery vastly easier.

HELICOPTER GYROS ON FIXED-WING MODELS?

Weary of administering first aid to lacerated wingtips, some ingenious scale modelers utilize dynamic yaw damping via gyro rate-dampers borrowed from the helicopter fliers' bag of tricks. Slipped into the rudder-servo electrical circuit, a gyro will remarkably tame a ground-loopy tail-dragger. The gyro senses yaw and moves the rudder in the needed direction about 10 times faster and more accurately than the most consummate stick artist. Many full-scale airplanes use gyro yaw dampers to reduce annoying yawing in rough air. Gyros can also be used on the roll and pitch axes to dramatically reduce rough air monkey motion. The tradeoff is a lazy feel, as though the model were much larger than it is—not a bad thing except for extreme fun-fly craziness.

KNIFE-EDGE AND LATERAL AREA (FIGURE 4)

The almost uncanny ability of many of the boxy, old-time, free-flight and very early R/C models to keep themselves out of trouble when severe turbulence upset them was, for me, an eye-opener. Knocked into a near-vertical bank, with virtually no wing lift left to resist gravity, they soldiered on—

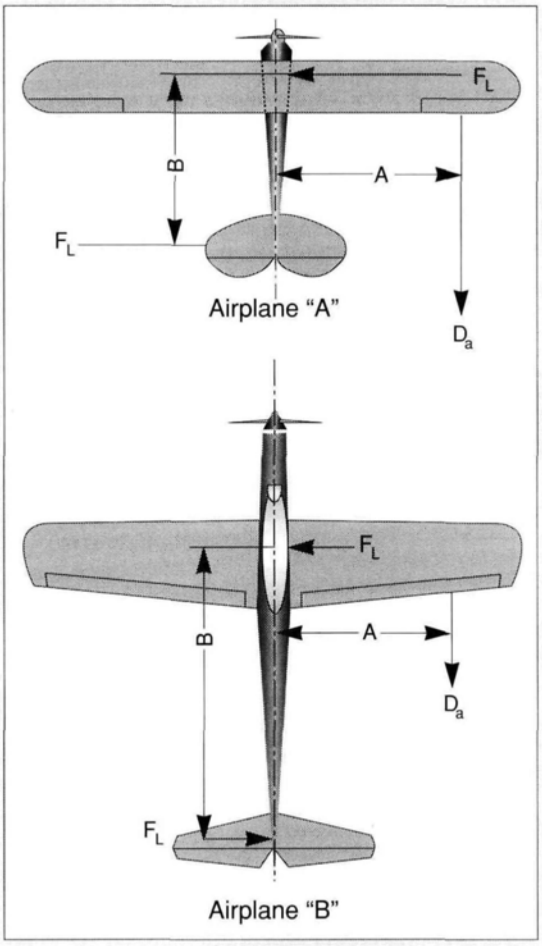


Figure 3

Effect of fuselage-length aileron and wing design on lateral forces

Airplane "A," with constant-chord wing and barn-door ailerons, develops higher aileron drag (D_a) than airplane "B," with tapered wing and full-span ailerons.

Aileron drag of airplane "A" also acts at a greater distance (A) from fuselage center line. Aileron drag moment (D_a x A) is much higher.

Aileron drag moment (D_a x A) must be resisted by equal and opposite forces (F_L) acting on the fuselage and vertical tail. Shorter spacing* between these forces reduces their relative leverage on airplane "A."

Airplane "A" needs much larger yaw-resisting forces (F_L) to avoid going out of control. Fuselage and vertical tail may be unable to provide such large forces.

Pattern model airplane "B," with a longer fuselage having greater lateral area, is able to develop far greater yaw resistance, while its aileron/wing design develops much lower yawing couples. The center of aileron drag is much farther inboard with tapered wing and constant-chord ailerons.

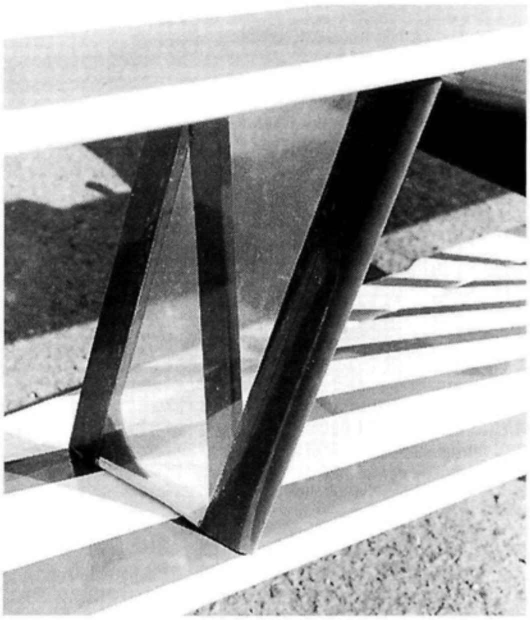
Result: airplane "B" has much better resistance to stall/spin and tracks straighter.

****Dimension "B"***

their slab-sided noses refusing to drop.

In a bank, unless the requisite amount of up-elevator is applied, an airplane starts slipping or flying partially sideways toward the low wing. The sideslip results in considerable aerodynamic force that acts on the fuselage and helps support the model. In other words, the fuselage acts like a wing. Aerodynamically, the fuselage is poorly suited to heavy lifting duty. It wastes a lot of energy churning up vigorous air vortices that generate tremendous drag, like an extremely low-aspect-ratio wing pulling a tight turn (only much worse).

In sustained knife-edge flight, the fuselage takes over most of the wing's job. Engine thrust inclined upward by yaw picks up the remainder. The rudder becomes, in effect, the elevator. One problem is that a considerable amount of rudder deflection is usually needed to supply the necessary download to hold the nose up and sustain knife-edge, particularly at less than top speed. Unfortunately, this download fights the lift and greatly increases the drag of the hard-working fuselage.



Airfoiled, clear-plastic-covered interplane strut (knife-edge "cheater" struts) on a 68-inch-span bipe.

A simple fix: reduce the needed download by adding fuselage area ahead of the CG, which moves the center of pressure forward. (Remember the guppy-like profile of pattern models a while ago, when knife-edge was more important, and the weaker, un-piped engines needed all the help they could get?)

Another tack would be to move the CG back. This would tend to destabilize the model in pitch, unless the wing were also moved back or wing sweepback were added. Additionally, wing sweepback places the wing root farther forward, and wing/fuselage interaction tends to move the center of fuselage lateral pressure forward. Otherwise, I don't like sweepback's trade-offs, particularly its stronger yaw/roll coupling.

Center of lateral area (and its enormous effect on lateral stability) has irresistibly attracted the interest of free-flight theory hackers for a long time, like a black hole in space swallowing a galaxy. In sifting through years of dusty reports, I have been put off by their habit of confusing center of lateral area with center of lateral pressure. A model responds to force, not to area. Fuselage shape, not just profile area, is all-important in generating aerodynamic force. A flat-sided fuselage presented to the air stream at an angle should develop roughly double the lateral force of a slippery, elliptical, or round cross-sectioned fuselage. Similarly, a fuselage with a well-rounded nose and a slab-sided tail cone should produce a center of aerodynamic pressure that is much farther back than a fuselage with the reverse layout.

Unable to rest until I had some answers, I rigged a crude wind tunnel and blew the dust off a bunch of carved balsa fuselages. Larger scale, carved Styrofoam fuselages held out a car window while pivoted on a threaded steel rod inserted through a series of holes, seemed to produce results with less experimental error.

Testing a bare fuselage distorted the picture. Adding stub wings and tails considerably affected the center of lateral pressure. It turned out to be located well ahead of the center of lateral area for fuselages of roughly similar fore and aft cross-sections. It also tended to move rearward as the yaw angle increased, approaching the center of lateral area at roughly the largest yaw angles encountered in normal flight. (I found the center of lateral area by finding the CG of a cardboard cutout with the same profile.)

One nice thing about fuselages forced to pinch-hit as wings in knife-edge flight is the near-total absence of stall break. Lift force seemed to increase rapidly at first, then more gradually up to about a 45-degree yaw angle, and fall smoothly to zero at 90 degrees. This was, in reality, only what should be expected of an extremely low-aspect-ratio wing. Lift coefficient was difficult to determine in my crude experiments, but it seemed surprisingly high—comparable to that of a normal wing. Drag was very high; I doubt that fuselage lift-to-drag ratio ever gets much higher than 2:1 at least at the sort of yaw angles usually needed for knife-edge maneuvers requiring some "G" load.

Armed with this knowledge, I pressed one of my original bipes into duty as a test mule to experiment with various combinations of lateral-area

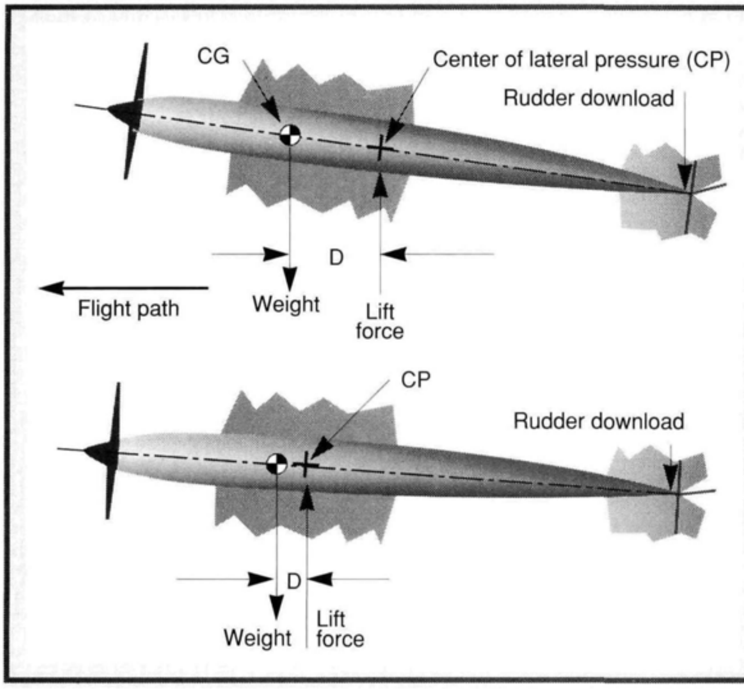


Figure 4

Effect of lateral center of pressure on knife-edge

Airplane "A," with its center of lateral pressure far aft of its CG, needs heavy download from the rudder/fin. Download opposes lift; the fuselage may be unable to produce enough lift force.

The rudder may be unable to develop needed download, causing the nose to drop. Yaw angle must be large.

Airplane "B," with its center of lateral pressure much closer to its CG, needs much lighter rudder download and much less rudder deflection. It will have a much stronger knife-edge. Locating center of pressure farther ahead may call for auxiliary lateral area or fuselage redesign. It's much more precise in rolling maneuvers.

additions. Obviously, too much lateral area up forward could destroy yaw stability by placing the center of lateral pressure ahead of the CG. The nagging question was: just how closely could the center of lateral pressure approach the CG before yaw stability and overall handling suffered, and what could be done to ameliorate the suffering?

Each increment of lateral area around the CG beefed up knife-edge, but surprisingly, didn't seem to hurt yaw tracking. A very generously proportioned vertical tail probably helped. Very wide-chord, airfoiled "cheater" interplane struts really helped level the nose in knife-edge. Area for area, covering the cabane did even more, presumably by plugging air leakage through the previously open structure. The center of lateral pressure seemed to be getting very close to the CG, as the necessary rudder deflection—even for slow knife-edge—was almost imperceptible. The usual rudder download had reversed direction and become helpful lift.

The (probably impractical) ideal would be knife-edge flight with no need of rudder deflection, and I was close. Another dollop of lateral area did it—hands-off knife-edge and horizon-to-horizon show rolls with no control input aside from a touch of aileron to keep the roll going. (The CG in pitch was also right at the absolute aft limit; no down-elevator was needed for sustained inverted flight.)

The only downside I encountered was a much-increased sensitivity to rudder trim. Rudder-linkage slop also proved surprisingly harmful, because the rudder's own weight tended to deflect it within the free play, hurting knife-edge. I tried full mass balancing (it helped) and even overbalancing (impossible to trim in yaw), before settling on a very light rudder with a tight, stiff linkage. The model would also glide, power off, quite nicely in knife-edge, with the nose level, albeit at a rather high sink rate and 45-degree descent angle at about 15mph horizontal air speed. In other words, in a 15mph headwind, it would descend straight down sideways, before needing to roll out at about 10 feet for landing.

In normal flight, lateral controllability was very solid, right into deep stall; if anything, it was better than before the area additions. Rolling circles, even at just a hair over stall speed, became easy. In short, the bipe was a very entertaining and pilot-friendly free-style device.

Rigorously analyzing this behavior could be tricky, but I think that as lateral area becomes larger in relation to wing area, the center of lateral pressure can be located closer to the CG without unduly compromising lateral controllability or stability. Exponential control on rudder, however, would be a good thing.

Blaine Stettler's NOTFORSALE sport fun-fly design, a *Model Airplane News* construction plan (FSP05931), is an excellent example of a far-out lateral-area experiment that worked. Lateral area has an immense effect on spin rate, knife-edge and, most important, the ability to survive excursions into territory that might otherwise spell deep trouble.

Non-aileron trainers have been advocated by some survivors of the R/C school of hard knocks. Such trainers, in my opinion, can benefit from the yaw resistance and damping produced by a deep fuselage; this reduces their tendency to seesaw in yaw when rudder control is applied a little too abruptly. One advantage of lateral control solely by rudder in a high-wing trainer is a tendency for the plane to display positive yaw/pitch coupling. (Remember those boxy old-time R/C jobs?) This is a big help in keeping the nose up during misadventures by tenderfoot fliers. Also, unlike those fickle ailerons, the rudder almost never quits. It may become over-sensitive, but it tends to stay effective into deep stalls that would render most ailerons useless. A good example is the Sig Kadet Senior—a chip off the old-timer block.

HINTS FOR TAMING YAW/PITCH COUPLING

Yaw/pitch coupling is a common peccadillo in aerobatic models and is a difficult thing to analyze. It seems to be produced by the complex air movement around a slightly sideways-flying fuselage (Figure 2). In a low-wing model, the positive air-pressure change over the root of the leading wing seems to be greater than the corresponding negative change over the trailing wing, producing pitch "down" with rudder-control input. The reverse happens to a high-wing model. Vertical position of the horizontal tail also seems to play a part. Raising the tail or adding sub-fin and sub-rudder area seems to add a tendency to pitch "down" with rudder. Adding sweepback (like a Cessna) or sweepforward (like a Mooney) may help to add pitch "up" and pitch "down," respectively, with rudder input. Otherwise, the trusty computer radio can come to the rescue by mixing a little elevator with rudder.

Enough for now. In the concluding installment, I'll briefly hit scale effect, tip plates, winglets, wing washout, turbulators and more, and I'll run through some simple fixes for poor-handling models. ■

C. DAVID GIERKE

VOODOO MECHANICS

I WAS QUIETLY working at my modeling workbench when, suddenly, the door to the "RPM" workshop banged open and in charged Frank Vassallo—my neighbor, fellow modeler and valued assistant in aeronautical experimentation.

"Dave, did you know that, in certain modeling circles, your February '94 article is being questioned?"

"Yes I did. I must admit, though, some of the comments that I believe you are referring to don't make a lot of sense."

Frank continued, "This one guy is trying to convince anyone who will listen that most engine break-in isn't necessary; I thought we did a pretty good job of explaining just the opposite in a column last winter" *(Model Airplane News,* February 1994).

"I thought so, too. We certainly received a lot of positive responses to that column. I guess the person you're referring to didn't read it."

"I think he did, Dave, but that's not what bothers me. That business about an engine not doing any work if it's only running on the test stand is *wrong;* it clearly contradicts several physical laws. This is voodoo mechanics, and it must be eradicated! Hand me that calculator. I've got some calculations to do!"

After he had pushed the buttons in a combination known only to Frank, there was a sudden, blinding flash of light. At first, I thought the TV set had exploded, but when my vision returned, everything was normal, but Frank had disappeared. In his place, the larger-than-life figure of Professor Physics stood wearing a mortar board (with tassel) and clutching a well-worn slide rule!

Figure 1. Frank had disappeared. In his place, the larger-than-life figure of Professor Physics stood clutching a well-worn slide rule.

I felt compelled to take notes; hurriedly, I grabbed writing materials and seated myself at the feet of the master. Described as a genius, Professor Physics has modestly proclaimed himself to be "the smartest person in the world" (no gender bias here)—a fact readily acknowledged by his peers, the superheroes.

"Greetings, Dave. I've decided to use your column to correct the myths that have recently been thrust upon the miniature aviation community concerning engine break-in."

I was thrilled that the professor remembered my name!

He continued: "I was appalled. Do you remember what he said about engines and work? It went something like this:

'When engines run on the bench, they do very little work. All they do is run up a good rpm and blow some air around. An engine does real work when it flies a model weighing 4 or 5 pounds at 70 or 80 mph!'

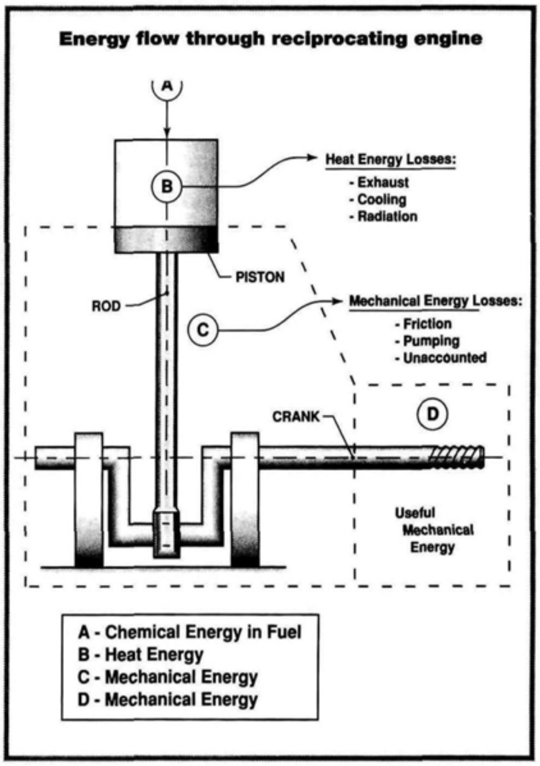


Figure 2. Letters A through D depict the energy flow through an internal combustion engine.

"To correct this and avoid misunderstandings, let's use the Socratic method; I'll ask a few simple questions and you try to answer them. Any objections?"

"No. I'll do my best, professor."

"What is work?"

"Ah, let's see; it's the expenditure of energy."

"Good! What is energy?"

"Hmmmm.... The ability to do work."

"Correct! What's the relationship between work and energy?"

"Well...They're the same; work is mechanical energy."

"Bravo!" exclaimed the Professor, to

my relief. "Now, what is the first law of thermodynamics?"

"The first law? Oh, you mean the Law of Conservation of Energy: energy can not be created or destroyed."

"Yes. If you can't destroy energy, what happens to the fuel that burns in the engine's combustion chamber when it's being run on the bench?"

I felt my face beginning to flush as thoughts raced through my mind; then it hit me: "Fuel is the chemical form of energy. As it burns in the combustion chamber, it changes into heat energy. Heat energy then changes into mechanical energy (work) when the piston moves, ultimately turning the crankshaft."

"You must have gotten your sleep last night, Dave. You've just proven that energy is being converted from one form to another and *work* is being performed—even if the engine is being run on the bench!" (see Figure 2).

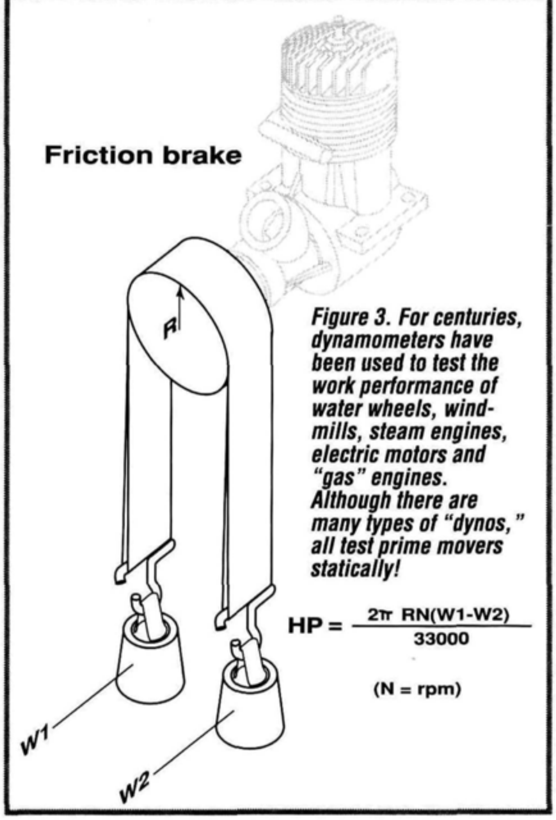
"That's great, Professor! Now, can you explain the role of the propeller? It absorbs the work being produced by the engine to blow air behind the test stand; it also propels the airplane through the air. Is there a difference?"

"I'll ask the questions, Dave! However, since you stumbled onto the correct track, let's investigate the propulsion question. Assume that you're operating an engine at wide-open throttle, on the bench, with an 11x8 propeller. The tachometer tells you that its rpm are 12,000; if the same engine/propeller combination were used on an airplane, what would happen to the rpm when the model achieves flight?"

"Well, from our flight tests using telemetry, we know the engine always speeds up."

"OK, Dave, does that indicate that the engine/propeller combination is working harder or less hard?"

"That's easy, professor. Because the engine always speeds up as it moves through the air, compared to sitting stationary on the ground, it does *less* work. If it were working harder, engine rpm would be reduced. So engines work less when flying straight and level than when running on the test stand."

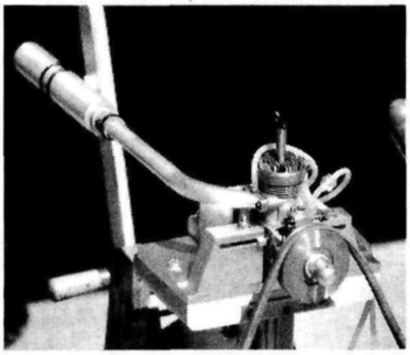


$$HP = \frac{2\pi RN(W1-W2)}{33000}$$

(N = rpm)

Figure 3. For centuries, dynamometers have been used to test the work performance of water wheels, windmills, steam engines, electric motors and "gas" engines. Although there are many types of "dynos," all test prime movers statically!

"That's basically correct, Dave. Allow me to provide clarification: imagine a piece of leather belt wrapped around the flywheel of an engine operating at 10,000rpm. The belt is being held firmly at both ends by a nervous assistant—you. The harder you pull against the rotation of the flywheel, the more the engine slows. The greater the load, the harder the engine *works*. A similar, more practical device is called a 'Prony brake'; it has been used for centuries to measure the torque and horsepower performance of rotary prime movers (see Figure 3). Please note that we're discussing the *static* measurement of work—the basis of all dynamometer testing. It's really quite simple: to change the amount of work an engine performs, simply change the load! In your case, changing the propeller changes the load."



During a recent muffler noise test session, unwanted propeller noise was eliminated by substituting a friction brake (grooved flywheel and leather belt) for the propeller.

"Wow, professor! What insight! You always do a great job of making physics understandable—with no math, either!"

"Thanks, Dave. I think readers of the 'RPM' column would agree: the physics is quite simple. You know, the funny thing about the comments made were how they unwittingly proved our point."

"Oh? I missed that one, professor. Please explain."

"Remember when it was said that a window fan will speed up when a large obstruction is placed in front of its inlet?"

"Yes, now that you mention it, I do remember, but..."

"Allow me to finish, Dave. He was trying to demonstrate that when air moves slowly through a propeller—when on a bench-mounted test-stand unit—less work is done. Of course, this is false. This analogy is faulty because his fan is cavitating (cavitation is the formation of a partial vacuum in the air by a swiftly moving propeller); the lack of air about its blades reduces the load and it speeds up. What he succeeded in showing was the relationship between load and work—just what we've been talking about. When the load was reduced, so was the work. We've

already demonstrated that the load on a propeller moving through the air is less than the load on one that is operating on a stationary test stand."

"A great deduction, professor! There's no question about it, engines work harder on the test stand than they do in the air."

"It's not quite that simple, Dave. The attitude of the model will determine the load on the engine and the work produced. If the model climbs, the effect of gravity acting on its mass will add to the load and to the work required of the engine, and it will slow down. Conversely, if the model is diving, the load on the engine and the work produced is reduced, and it will speed up (see Figure 4). With physics, Dave, nothing is ever black or white, but one thing is sure: *an engine running on a test stand is definitely producing work!* My work is done for now, Dave, but remember, when physics is maligned, *I'll be back!*"

With a flip of his tassel, Professor Physics disappeared in another brilliant flash of light, only to be replaced by my faithful companion, Frank, who was still frantically pushing buttons on the calculator.

"What the heck, Dave! No wonder I can't do these calculations: you gave me a TV remote control instead of the calculator!" (It seems as if I've heard this before...).

"Let's take a break, Frank. It's time for a good Canadian ale!" ■

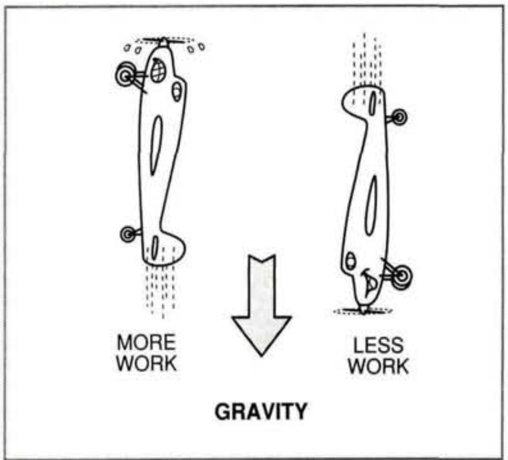
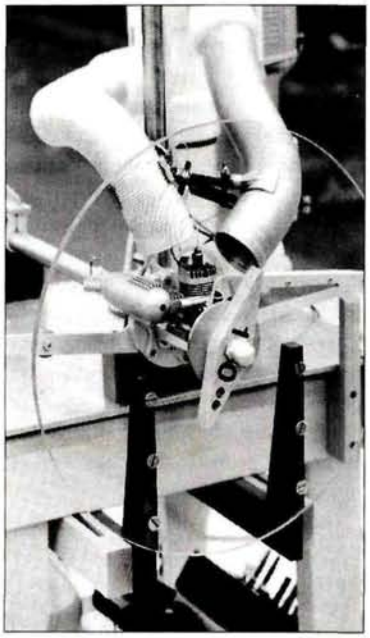


Figure 4. Gravity provides a change of load (and work) for the engine during various flight attitudes.

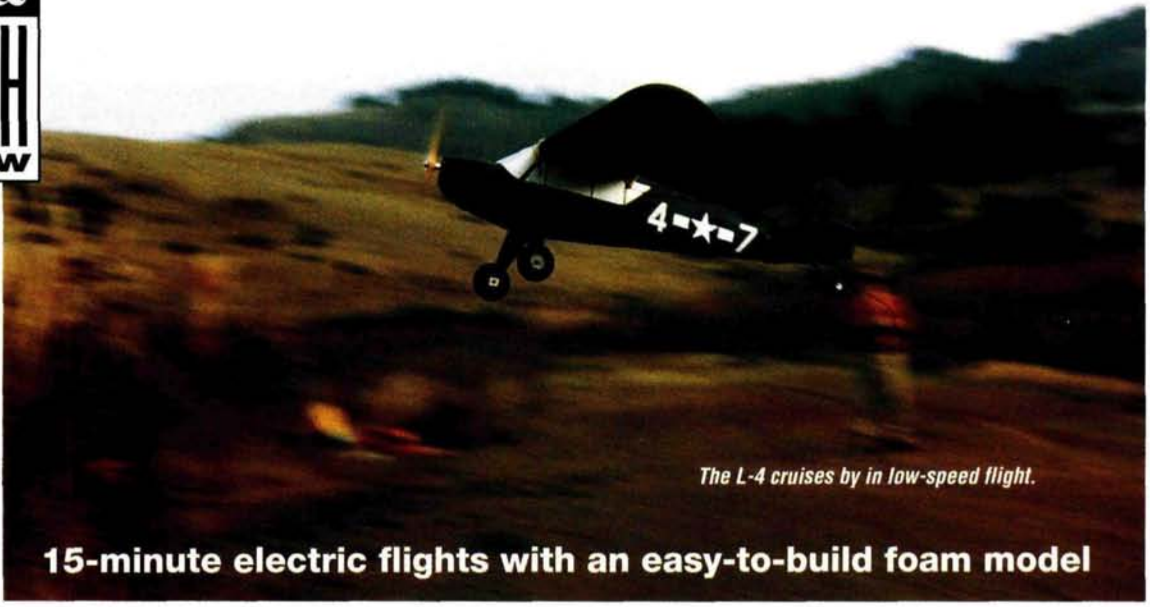
What's a Dynamometer?

To regular readers of the "RPM" column, the engine dynamometer is a familiar piece of test apparatus; if you're new to these ramblings, a brief description is warranted. A dynamometer ("dyno," or "torque stand," as it's sometimes called) is used to measure an engine's crankshaft torque and rpm; this is performed at various shaft speeds as dictated by a variety of loads ranging from light to heavy.

All of these tests are run at wide-open throttle and require many starts and stops to change loads. The data collected from a dynamometer is used to graphically plot an engine's torque characteristics throughout its practical operating range. After a few calculations, the engine's horsepower characteristics can be plotted for this same range. Instead of propellers, pitchless wooden beams are used to load the engine for a variety of reasons; load-beams don't direct a blast of air around the cooling fins, so another method is used to cool the engine. A squirrel-cage fan supplies air to the cooling fins and is regulated by an electronic speed control.



FIELD & BENCH REVIEW



The L-4 cruises by in low-speed flight.

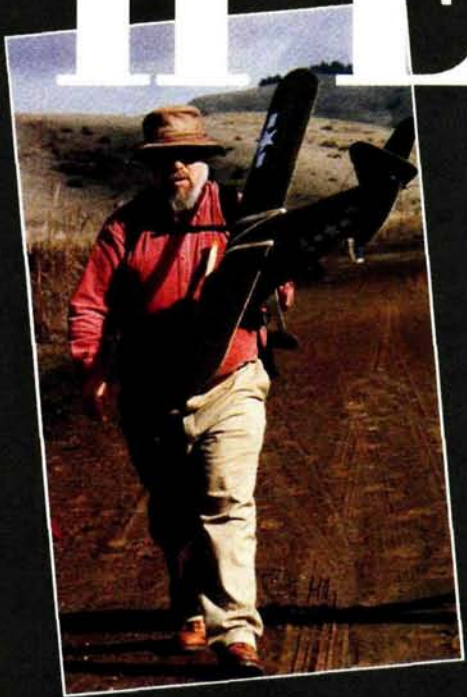
15-minute electric flights with an easy-to-build foam model

PHOTOS BY JEF AND AZA RASKIN

MODEL ELECTRONIC CORPORATION'S

PIPER L4

by JEF RASKIN



EVERYBODY WHO FLIES R/C is probably aware that electrics can have enough power to do vertical climbs, to take off from water and to do pattern-style aerobatics. But, until now, if you just wanted to go out for some weekend flying, shoot a few touch-and-go's and keep the plane in the air for the usual 10- or 15-minute sport flight, electrics just didn't have the duration—unless you went to some long-winged glider-type contraption.

But, for the first time (as far as we know), the 15-minute barrier has been broken using an off-the-shelf, easy-to-build, all-foam scale model. It uses reasonably priced components that can be readily purchased from standard hobby outlets. Not only is it easy to build, but what you get is also no lily-livered barely-dragging-itself-into-the-air weakling; you get a model with a good strong climb and the power to punch through 15mph headwinds. We are getting motor runs of up to 17 minutes, with enough power left after landing to taxi back from the far end of the runway (and then some).

This article is not so much a review as a story of a collaboration. Help and encouragement came from fellow San Francisco Vulture club members, especially Abraham Hao, Yesso Tekerian, Ralph Voorhees and Aza Raskin and from the nice people at Sure Flite*. But Pete Peterson, president of Model Electronic Corp.* (MEC) was the key collaborator; he provided important information, spent lots of time on the phone, traded faxes with me and sent a variety of parts so that we could zero in on the perfect combination.

In our first call, I told him that I wanted to present our readers with an easy-to-build, good-looking electric model that would have a motor run of at least 10 minutes. To make it tougher, I mentioned that the motor had to run on common 7-cell packs that require only inexpensive and readily available chargers. I specified that it must not need a fancy runway for takeoff and landing. "Is that all you're asking for?" Pete wanted to know. No, I also demanded something that looked like a recognizable, real plane, and I suggested that their L-4 might be a good test bed.

It took a few tries and a crash or two as we climbed the learning curve, but the results will convince the last few scoffers out there that electrics are the can-do planes of the 1990s and beyond—even for the casual flier who wants air time with a minimum of fuss. Now for the details, so you can get the same results as we did.

Things You'll Need

- Model Electronics Corp. (MEC) Piper L-4 electric kit
- MEC Sport GT motor
- FX35 controller (also available from MEC)
- Sure Flite extra Piper Cub wing (if you want a scale span and increased flight duration)
- Master Airscrew electric 12x8 propeller
- Satellite City UFO CA glue
- SR Batteries 1800mAh 7-cell pack
- Peak Performance* battery charger (I use the Astro Flight model 111)
- Sermos connectors
- Lightweight 3-inch wheels
- ¾-inch tail wheel

Rubber bands are not the most elegant means to hold down the wing, but they work just fine. We've had a few crashes but no broken wings with this system.

The motor is mounted to a plywood plate, which is glued to a second plywood plate that's glued to the foam fuselage. The screws that hold the two plates together have been removed and the motor moved forward. This arrangement facilitates servicing the motor. The fuselage cracks just behind the reinforcement are from a nose-over (a bit of UFO fixed them). The entire cowl area should have been reinforced.

THE PLANE

In WW II, the well-known Piper Cub was converted into the L-4 and was used in liaison, reconnaissance and ambulance duties. This model of the L-4 aircraft comes with D-day markings and vacuum-formed scale engine parts. I used Testors* Model Master Olive Drab spray paint (no. FS 34087) to get a good-looking flat finish. With care, two cans will do the job, but three is a more comfortable number. Their matching bottled paint is what you want for touchup.

The kit started life as a Sure Flite 50-inch-span all-foam model designed for wet power. MEC cleverly converted this kit into a very successful electric. But the MEC conversion required a 9-cell battery pack and did not have the flight duration I wanted.

The right motor was a key ingredient. MEC initially recommended their War Emergency power motor, but their more efficient GT Sport motor turned out to have more than enough power and greatly increased flight duration. The gearbox was set up to give a 6:1 reduction ratio.

For duration, it's important to have an efficient speed control. The Ai/Robotics* FX35 microprocessor motor controller is a winner in this regard. You have to cut the green jumper to get its best duration, but the instructions tell you how and why it all works. The FX35 is a pleasure to set up since there are no adjustments. It has a microprocessor on board to take care of the busywork, and it also provides important safety features, such as not allowing you to turn on the system and have the motor start at full bore (you can only power on the motor if the throttle stick starts at its lowest position). To further save weight, I used the FX35's battery eliminator circuit (BEC) to power the receiver. In more than 40 flights, there have been no radio glitches at all.

Success would not have been possible without the highly efficient Master Airscrew* electric wooden props. With their fine finish and yellow tips, they look good on the model. I tried a number of other props, all of which worked far less well. With some of the wrong props, the plane would barely fly; but the Master Airscrew electric 12x8 pulls the plane aloft with a less-than-20-foot ground run at full

SPECIFICATIONS

Model name: Piper L-4
Type: electric-powered sport scale
Manufacturer: Model Electronics Corp.
List price: $79.95
Wingspan: 50 in. (57 in. as modified by author)
Wing area: 400 sq. in. (460 in. as modified by author)
Airfoil type: 16-percent thick, about 6-percent camber, flat bottom.
Suggested weight: 54 oz.
Actual weight: 50 oz.
Length: 39 in.
Motor: MEC Super Sport Turbo 10 GT
Gear ratio: 6:1
Propeller: Master Airscrew electric 12x8
Speed control: Ai/Robotics FX35 digital motor control
Transmitter used: Ace R/C* Micropro 8000
Receiver used: Hitec/RCD* Micro-535 receiver
Servos used: Ace R/C Micro 380, Hitec/RCD HS-80
No. of channels: 3 (rudder, elevator, motor)
Flight batteries: SR Batteries Magnum 1800mAh 7-cell
Construction: all foam

Hits
- Good appearance; doesn't look "foamy."
- Easy to build.
- With the mods suggested here, electric performance and duration are spectacular.
- Quality materials and, except for gearbox assembly, very good instructions.

Misses
- Wing attachment could be improved.
- Needs reinforcement that's not explained in the instructions.

FLIGHT PERFORMANCE

• Takeoff and landing

Takeoff is fast and easy at full throttle if the CG is where you were told to put it and you have tail-dragger experience. Until you get handy with the rudder, the plane will run as straight as a scared rabbit, which is to say, it will zig and zag and head off for the tall grass. Right trim of $\frac{1}{16}$ inch in the rudder helps. At lower throttle settings, the takeoff is very scale-like. Both wheel and 3-point landings are very easy. Use up-elevator when taxiing (you shouldn't use down-elevator when taxiing a tail-dragger downwind; that should get an argument going!).

• High-speed performance

It's easy to fly fast enough to make the plane look unrealistic. I don't see why you would want to. It isn't a fast plane, and it isn't supposed to be.

• Low-speed performance

Low-speed handling is very good. Stalls are straight ahead, but if you add rudder in the stall, the plane can be made to snap. With straight-ahead rudder, you can slow the plane down to a crawl.

• Aerobatics

This plane was not designed for aerobatics. I have successfully, if sloppily, flown loops, rolls, inverted flight, hammerheads and snap rolls, but I don't recommend the plane for aerobatics.

• Duration

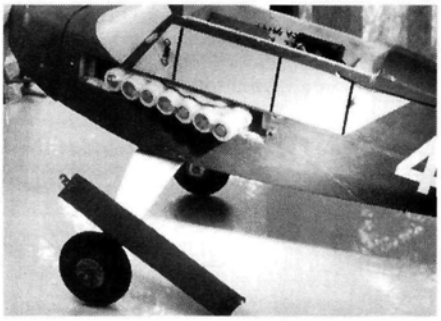
With the short wing, 14-minute motor runs are normal. With the long wing, 17 minutes are possible. The plane climbs at a click or two above half throttle. For practicing takeoffs and landings, you can expect about 10 flights on a single charge, including a few missed approaches. Our best was 14 flights on one charge.

throttle, and gives much more realistic takeoffs at $\frac{3}{4}$ throttle. For maximum duration, I used the SR Batteries* 1800mAh Magnum battery pack, but even a decade-old, anemic 1200mAh 6-cell pack gave $8\frac{1}{2}$-minute motor runs. (I do not recommend using six cells, but they will fly the plane.)

The model tracked true on 3-inch-diameter wheels that handled our strip's gravel and ruts with ease (it's an old quarry road, mud covered and beaten up by heavy trucks). The L-4 is not, as the instructions honestly point out, a trainer. You have to be secure in tail-dragger technique: decisive but gentle with the rudder on takeoff and landing and aware of the need to hold up-elevator while taxiing. Incidentally, the idea that you should hold in down-elevator when taxiing downwind (I've seen this in model magazines many times) is a classic error. Foam does break easily on a hard landing, but repairs made with a bit of Satellite City*'s UFO, spackle, a few moments of sanding and touchup paint are fast and completely invisible. This is a very repairable model.

BUILDING

There isn't much to build; the airframe is five big parts that fit well. Don't bother installing ailerons; the plane flies well with rudder and elevator. I tried it both ways and never hooked up the ailerons again. MEC's instructions for the plane are quite detailed and are laid out step by step. I always appreciate it when the manufacturer doesn't make you guess. I wish the gearbox assembly instructions were also step by step. I had to puzzle them out and, what could have been an easy five or 10 minutes, became a brain-wracking



The batteries go in a convenient door in the side of the fuselage. This photo was taken after months of flying from a muddy runway!

hour. The plywood is of excellent quality, but you have to do the layout and cutting yourself. The foam cowl area of the fuselage is not quite strong enough to support the motor in hard landings. Use UFO and one layer of $\frac{3}{4}$-ounce fiberglass over the cowl. I smooth on the UFO with a polyethylene plastic bag over my hand. Pete uses wax paper. It takes a few minutes and looks just fine.

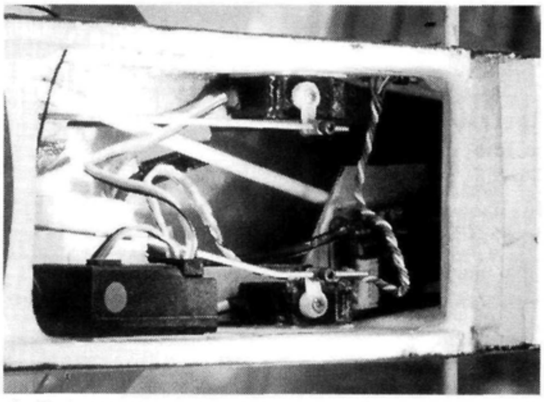
To make dead-straight runs for the fuselage pushrods, I used a 12-inch-long drill bit. This makes a straight hole from the control exit to the servo arm, and that's better than the recommended curvy route. One caution in the electrical hookup department: don't use the Tamiya- or Kyosho-style connectors that come on most battery packs. After I had one of these connectors burn up (literally, with a handsome smoke trail) in flight on a previous plane, and had two others melt, I switched to Sermos* connectors and have had no problems since.

This is not a precision scale model, so I put on the stickers where they looked good to me. So don't write to tell me that no L-4 ever flew in this livery; I already know it.

MORE SPAN FOR BETTER LOOKS AND DURATION

The plane looked sort of stubby in the air, so I measured the wing and found that it

Left: Marks show in this photo, taken after 58 flights (not including crashes or off-runway landings). The epoxy-coated $\frac{1}{64}$-inch ply is essential. I use double-sided tape to mount servos in slow electrics; they've never shifted or come off.



Radio installation is trivial. One servo is mounted on each side, the receiver in back and the speed control up front. All were installed with double-sided tape attached to lite-ply.

was a full 7 inches short of scale. I got an extra wing and, by cutting off the tips and inserting an extra section on each side, I achieved scale span and appearance. This modification not only looks better, but it also smoothes out the flight path and adds at least 2 minutes to the flight time. It would be easy to cut out two 3½ inch pieces with a foam cutter to make your own modification. I put a strip of ¾-inch fiberglass strapping tape across the bottom of the wing for a bit of extra strength after the operation.

Dynaflite* Control Horns

I learned about these because they were provided with the kit. They are possibly the fastest and easiest-to-mount control horns in history and are one of the best-kept secrets in the world of R/C modeling. Available in short and long versions, you just make a slit in the control surface, slip them in, push on the retainer, and cut away the excess. No screws to fiddle with, and the installation will stay in place. A drop of CA will firm up the wood (or UFO CA for foam) around the slit. You can carefully pry off the retainer, if you have to.

CONCLUSION

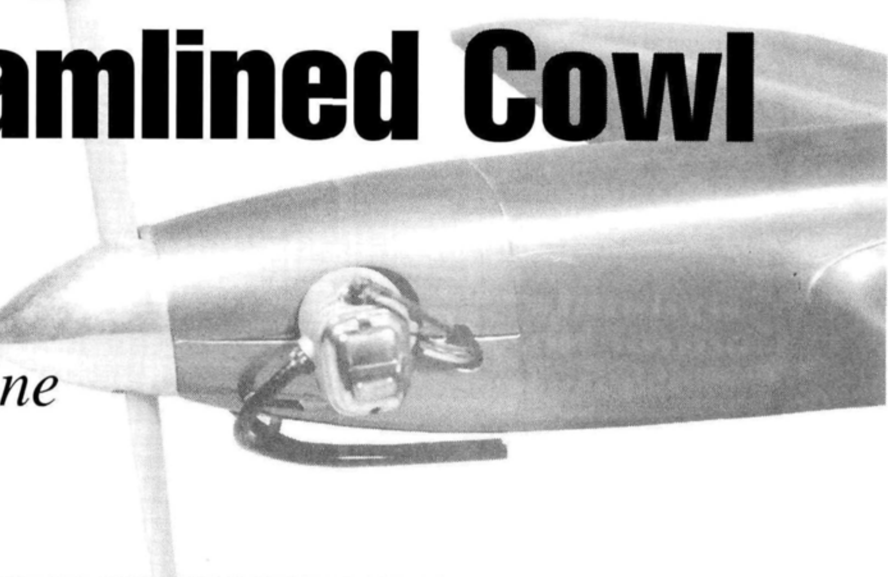
When I started this project, I was looking for an honest 10 minutes of powered flight. With the L-4, the extended wing, the GT motor, the 12x8 prop and the other equipment I've mentioned, the longest powered flight has been 17:25 minutes; with the short wing, 14:30 was common. That's not bad for a stock electric. As the photos show, the plane looks pretty good on the ground and in the air.

If I were to do it again, I'd shorten the landing gear to a more scale-like length, which would also decrease weight and drag. I am tempted to try an entirely new wing, because the one provided has a draggy 16-percent-thick airfoil (ideal for Sure Flite's original intended use, but not for electrics). Calculation shows flight times of over 20 minutes should result! This Model Electronics Corp. L-4 is a satisfying project that can quickly give you a quiet, solid, sport model that's perfect for practicing tail-dragger technique, touch-and-go's and just plain flyin' around on the weekend. And your friends will be amazed at how long it stays in the air!

*Addresses are listed alphabetically in the Index of Manufacturers on page 130. ■

HOW TO

Build a Streamlined Cowl

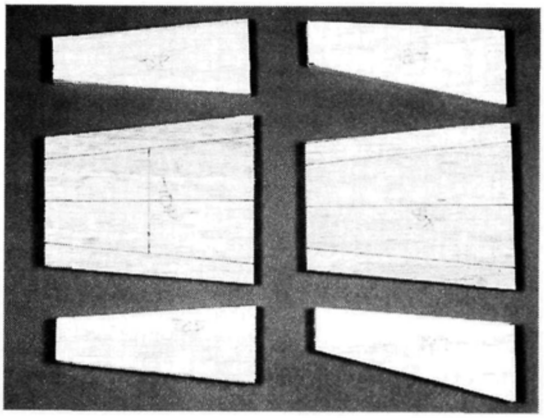


Turning balsa into a custom-fitted engine enclosure

by FAYE STILLEY

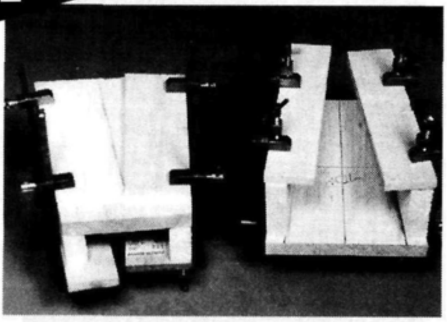
THIS IS THE second in a three-part series on how to design and make a streamlined cowl. The first part detailed the design techniques. In this part, I'll show you how to build a cowl using those techniques, and in a concluding article, I'll show you how to cover it.

1



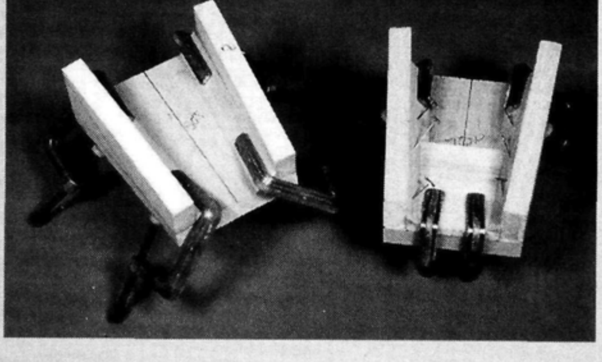
Take measurements from the plans, and cut the cowl parts out of balsa wood. Draw reference lines to help with the placement of the parts while you glue. You're probably thinking, "I did all that drawing and planning to get just six little pieces of wood?" It's because of all that drawing and planning that everything will fit together perfectly the first time, and you won't have to do it over again. So much for philosophy; things are going to happen much faster from here on out.

2



Glue and clamp the parts together. Use an aliphatic glue; it's much easier to sand than epoxy or CA. We're attempting to make *one* piece of wood out of several, so tighten the clamps as much as possible without crushing the wood. Use pieces of plywood or hardwood to protect the balsa from clamp dents.

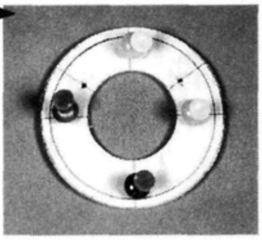
3



When the glue has dried thoroughly, cut the ¼-inch-thick stock and the triangle stock and clamp them into place. Clamp pressure is important because the triangle stock must be pressed as tightly as possible to avoid gaps on the sides. Gaps here will cause holes in the surface of the cowl when it's shaped. Note that where clamps can't be fitted, pins are used to put pressure on the parts.

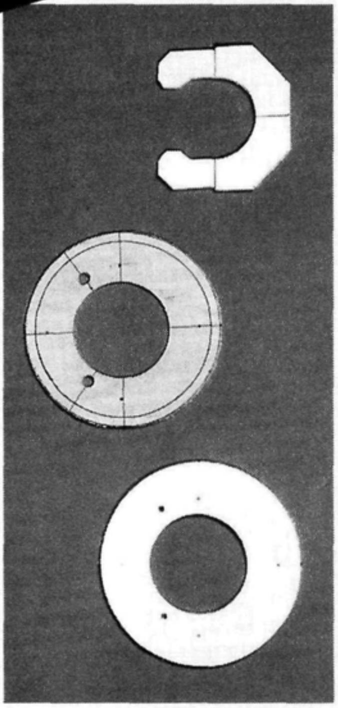
PHOTOS BY FAYE STILLEY

4



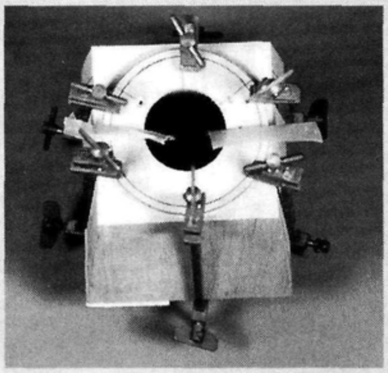
The nose ring is made out of two pieces of plywood that are laminated together. The front piece is 1/16 inch thick and the back piece is 1/8 inch thick. Mark all the reference lines on the 1/16-inch-thick stock, which is on top of this "sandwich." Pin the two pieces together, and drill the center hole. Then drill two clearance holes for the mounting screws. Machine screws will be used, so the holes should be snug, but the threads shouldn't catch. Finally, while the two pieces are still pinned together, make the outer cut using a scroll saw.

5



Separate the two pieces of the nose ring, and drill holes—large enough to provide clearance for the machine screw heads—in the forward ring (1/16-inch-thick plywood). This allows the screw heads to be recessed into the forward ring where they won't interfere with the spinner. Before you separate the rings, draw a line on the edges of the two pieces at the horizontal and vertical center lines. This facilitates perfect alignment when they're glued and clamped together (again, use aliphatic glue). When they've dried, cut them apart at the horizontal center line. Use as thin a saw blade as possible because the width of the kerf will affect the roundness of the nose ring. Table-saw blades are more than 1/16 inch wide, so if you use one, you should also use shims of thin plywood to replace the wood that's removed by the saw. Cut the cowl attachment plate out of 1/8-inch-thick plywood, and draw center lines. The lines will help with placement when the plate is finally glued into the lower cowl half. The holes for the blind nuts aren't drilled until later when everything is finally aligned correctly.

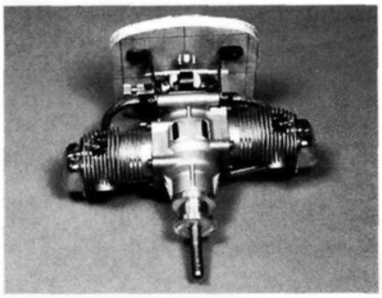
6



To hold them in alignment, tack-glue the upper and lower cowl halves. The glue "tacks" should be made on the inside of the cowl and away from either end; they'll have to be broken away later so, if any wood is torn away, it will be on the inside where it can easily be replaced. The inside edges of the cowl will be shaped later; this usually corrects any minor wood damage. Sand the front and rear surfaces of the cowl halves flat so that they match each other perfectly. Then glue the nose ring, and clamp it into place (once again, use aliphatic glue because this area will need careful sanding later). To prevent any accidental bonding, insert wax paper between the nose-ring halves and between the cowl halves. While the assembly is drying, build a mock firewall fuselage section.

7

I build my mock firewall out of plywood and attach the engine to it. The shaping of the cowl openings and the inside clearances involves a lot of dry-fitting to the engine while it's bolted in place. I find it much easier to work with a mock firewall rather than working with the engine after it has been bolted to the fuselage. The mock firewall fuselage section is easy to make because a complete drawing of it was made back in the planning stage. All the reference lines have been drawn on it, including the inside edges of the balsa cowl. Making the mock firewall isn't necessary if you don't mind working with the engine after it has been bolted to the fuselage.



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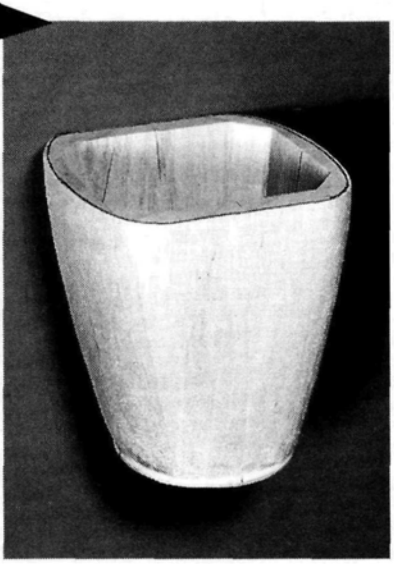
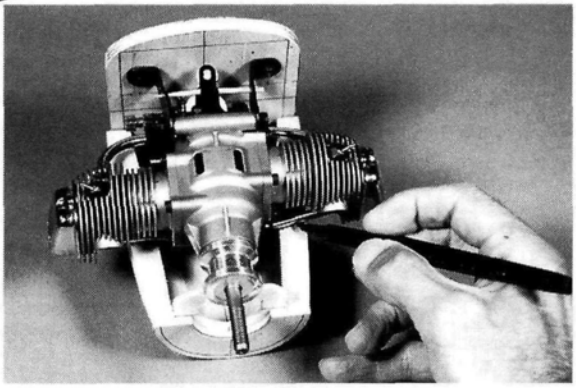


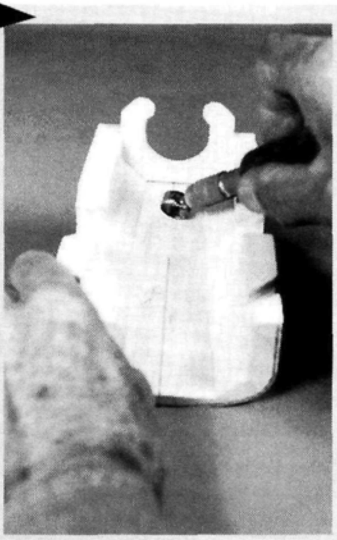
When the cowl "box" is completely dry, remove the clamps and rough-shape the cowl. Carve and sand the wood so that it's about 1/16 inch larger than the final shape it will be at the firewall end and about 1/16 inch larger than the outer circle on the nose ring. Note the line drawn around the firewall end of the cowl. It indicates the finished shape of the cowl and was drawn using the mock firewall. It could also be drawn using the firewall plan that was made earlier.

9



Separate the cowl halves, and glue the nose-ring backplate into place. Now the engine fitting begins. The process is the same with or without a mock firewall. Place the lower cowl section up against the firewall, then slide it up against the engine; mark where the engine touches the cowl edge. In this particular case, the valve pushrods below the cylinders hit the cowl edge before anything else does. By cutting away only a small amount of wood and fitting as you go, the size of openings in the cowl can be minimized. This gives the cowl a custom-tailored look rather than the look of something that has a big hole gouged out of its side.

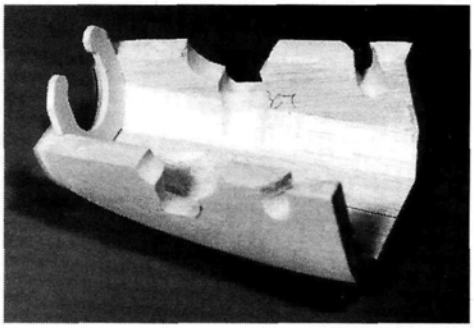
10



As the engine is fitted deeper into the cowl, it may bottom out against the bottom piece of the cowl. We already have a pretty good idea of whether or not it will because of our plan. X-Acto makes gouging tools in many sizes, all of which come in handy for this kind of work. Simply cut off the wood that's in the way. Then finish cutting the clearance holes in the side of the cowl.

11

Shape the lower cowl so that it provides engine clearance. This is only for engine clearance and not for aesthetic purposes. The aesthetics and the final sanding will be completed later. Part of the triangular stock had to be cut away for clearance. The inside edges of the lower cowl's parts that mate with the upper cowl have been beveled. It's much easier to perfectly match the two halves if the mating edges are only about $\frac{3}{16}$ inch wide rather than $\frac{1}{2}$ inch wide, which is what the balsa sheet is. This doesn't sacrifice any strength, because the bevel is shallow; it just facilitates a better fit.



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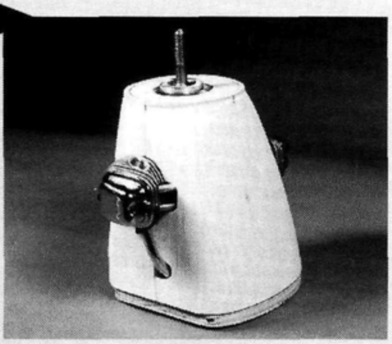
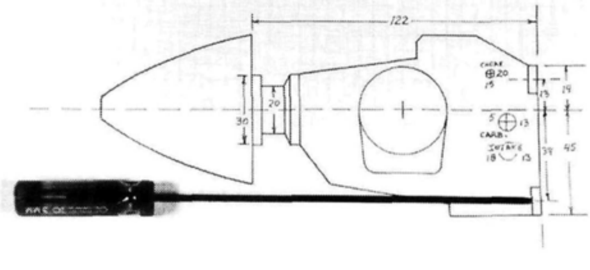


The engine clearance holes in the upper cowl half are complete. The horizontal center line on the firewall ensures that each half will have the proper amount of clearance when everything is finally attached to the fuselage. It's not visible in the photo, but the cutouts for the cylinders in the upper and lower cowl halves aren't the same size; they've just been cut to a minimum size to provide engine clearance. In the final finishing stage, they'll be shaped so that their mating edges blend together. The access hole for the needle valve hasn't been cut; that and any other control function access holes are made during the final finishing stage.

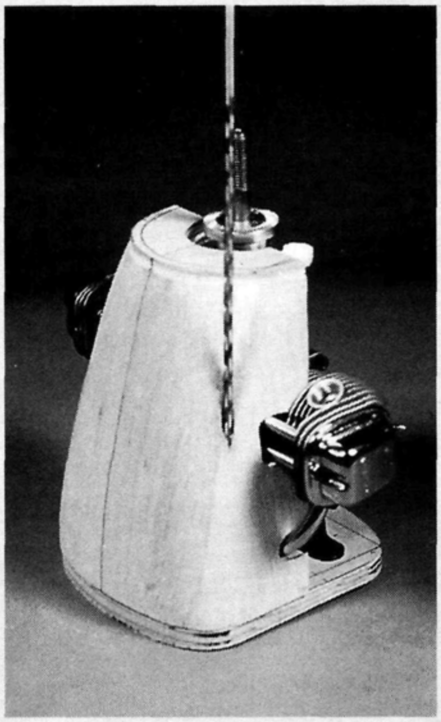
13

To avoid having unsightly screws on the outside of this cowl, I designed it so that the lower half is mounted permanently on the firewall and becomes a part of the fuselage. Because access to the engine-mounting bolts must be provided, I put holes in the cowl so that a ball driver can be inserted in a straight line to the socket-head mounting bolts. The drawing is used, once again, to test the feasibility of direct-line access to the bolts. As you can see in the photo, even the ball-driver handle clears the spinner. The ball driver is also the correct length. In some cases, this mounting technique requires the removal of the spinner to allow clearance. No big deal! How often do you remove and replace an engine?



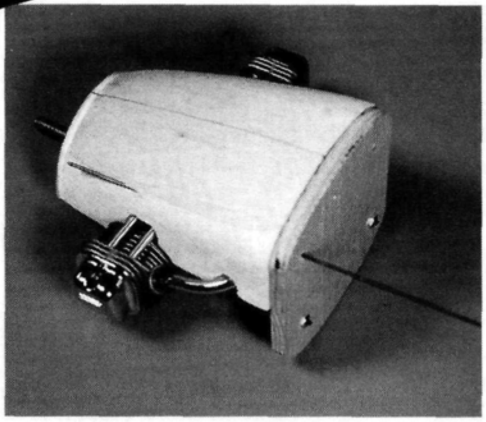
14

From the side- and top-view drawings, take measurements to determine where the ball-driver entry hole should be made. The easiest way to locate the entry hole is to measure from the horizontal and vertical center lines. You may be surprised by how far from the cowl's nose the hole will be.



Begin by sharpening one end of a piece of 1/16-inch-diameter piano wire, and rub it down with soap. Put the lower cowl in place on the firewall, and push the piano wire through the cowl to the center of the mounting hole. This may take a few tries because the wood's grain can divert the wire from a straight path. Once you're satisfied with the pilot hole made by the wire, use a long drill bit—preferably smaller than 1/8 inch diameter—to complete the hole.

15



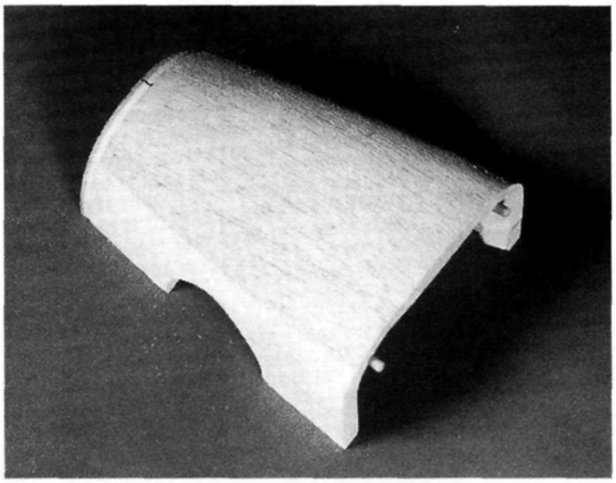
If you've made a mock firewall, this process is much easier: simply push the piano wire through the firewall's mounting hole (from the rear) and straight out through the forward section of the cowl. Use a drill or small rat-tail file to enlarge the hole just enough for the ball driver. If the hole is too large, the ball driver will wobble and not hit the center of the socket-head bolt accurately. Later, the holes in the cowl will be fitted with an "air scoop," which is actually a pushrod exit guide with the open end facing forward (see Photo 1). The air scoop delivers cool, fresh air to the carburetor, which is behind the engine inside the cowl.

16

Two machine screws hold the front of the cowl in place, and two small pieces of dowel hold the rear. When they're installed in the plane, there are no mounting fasteners in sight. I use 1/8-inch-diameter dowel because strength isn't important. Any size hardwood dowel can be used as long as there's room for it in the rear surface of the upper cowl. The dowel should be pointed on one end, to ease the insertion into the balsa, and rounded on the other for insertion into the firewall. Tack-glue the lower cowl to the "real" firewall, and install the engine. Pay careful attention to the horizontal center line on the firewall when you tack the lower cowl into place; the cowl will be removed once more before being permanently attached.

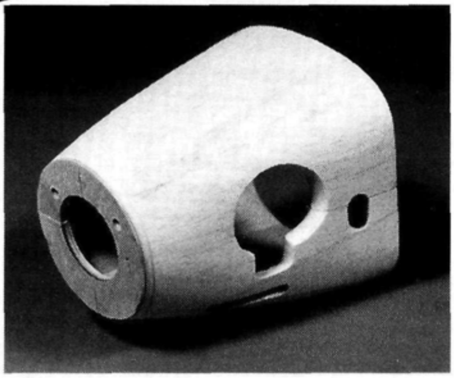
This is the final step in aligning the cowl with the fuselage and the engine. Put a small dab of paint on the ends of the dowels, and slide the upper cowl into place against the firewall. The paint will leave marks on the firewall where the holes for the dowels are to be drilled. Remove the upper cowl and drill the holes in the firewall. Re-install the upper cowl and, running the drill bit through the screw holes that are already in the nose ring, drill small pilot holes in the backplate. Remove the cowl, drill out the holes in the backplate, and install the blind nuts. Re-install the cowl, and screw it into place with the machine screws (be sure to go through the nose ring).

One last alignment step, and the finish work can be done. Install the spinner backplate, and re-trace its circumference. Use a different color pen or pencil than you used the first time. If there were any small alignment problems during the construction, they'll show up now and can be corrected during the final sanding. A cowl looks horrible if the spinner doesn't fit perfectly.



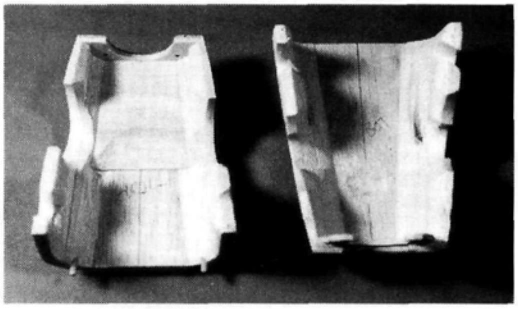
STREAMLINED COWL

17



Remove both the upper and lower halves of the cowl, and screw them together with the machine screws. Do the final shaping of the cowl (from the nose ring to near the back where it meets the firewall). The rear of the cowl will be shaped, along with the fuselage, when it's finally attached. Use the new circumference line (just drawn around the spinner backplate) to shape the forward section. Match up the side openings in the upper and lower cowl halves where they meet. Bevel the inner edges of the openings so that they look thin from the outside. This eliminates the "block-o'-wood" look that you get when thick pieces of wood are visible around the openings. Make the access openings for engine adjustments. Final-sand all the openings except the exterior of the cowl. The final sanding of the exterior is done after the cowl has been attached to the fuselage.

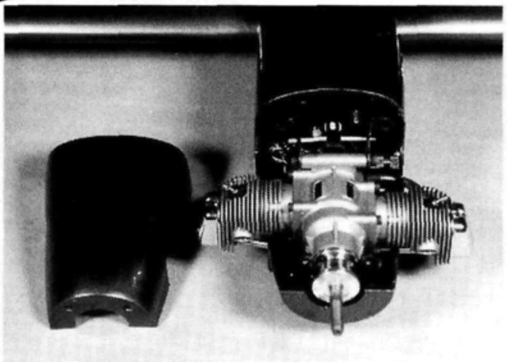
18



Once again, separate the cowl halves. Lightweight fiberglass should be applied to the inner surfaces for strength. Polyester resin is easier to use than epoxy and works as well for this purpose. Avoid getting the resin on the mating surfaces of the cowl halves and on the rear surface where they meet the firewall. Also, avoid getting the resin on the exterior surface of the cowl. If you do, wipe it off with a rag that's saturated with alcohol. Alcohol removes resin and thins any that has been absorbed by the wood. If you've drilled holes for a ball driver, coat the interior of the hole with resin to make it fuelproof.

Finally, glue the lower cowl permanently to the fuselage. Fuelproof the firewall with resin. Install the upper cowl, and bolt it into place. Shape the rear part of the cowl and fuselage where they meet. All that remains to be done is the finish-sanding and covering or painting.

19



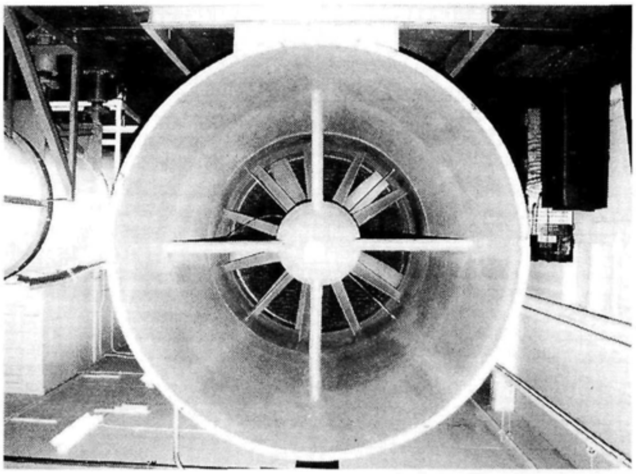
Everything fits! Here's the finished cowl with everything installed. In addition to the engine, fuel and pressure lines and the throttle pushrod, this installation also has wiring for onboard plug heat and an engine synchronizer, and it has a crankcase vent tube. All of these are contained within the cowl and hidden from sight. ■

CENTER ON LIFT

MICHAEL LACHOWSKI

WIND-TUNNEL TESTING UPDATE

This month, I'd like to update you on the wind-tunnel testing at the University of Illinois at Urbana-Champaign (UIUC). It hasn't taken very long for kit manufacturers to start using some of Michael Selig's newest airfoils. One of these new airfoils is the S7012, and it's available on the 2-meter Vulcan. I also have some information about using composite reinforcement strips and sanding techniques to true the airfoil.



A 125hp variable-frequency AC drive sucks air through the wind tunnel, which spans 60 feet overall.

WON'T THERE BE A BUMP?

If you haven't built a foam wing, you might wonder what happens when you put reinforcements, such as fiberglass or carbon fiber, under the sheeting. Yes, you will have a little bump in the sheeting, which will have to be sanded after the sheeting has been applied. Don't start sanding until the epoxy has fully cured. This process takes a few days, so be patient.

The trick here is to shine a light on the surface that you want to sand. I use an 18-inch fluorescent lamp to guide me, and I turn out all the other lights. By shining the light across the surface and looking almost directly toward it, you can see shadows created by bumps or ridges in the sheeting. Mark the high spots with a pencil, then sand those areas. Sand off the pencil marks, and check the surface again. Use the marks to make sure you sand the whole length of the wing evenly. To avoid creating flat spots, sand across the chord and not along the span.

UIUC WIND-TUNNEL UPDATE

What's happening with the UIUC low-speed-airfoil testing? More than 300 hours of wind-tunnel test time have been logged, and airfoil-performance data has been created for more than 30 airfoils for free-flight models, R/C sailplanes, sport planes and more. Let's look at how this might change R/C soaring.

The UIUC tunnel is an improvement on the Princeton tunnel. Measurements are now being made with a 16-bit A/D converter instead of a 12-bit converter, and this means more resolution in the data. More than 80MB of raw data had been recorded by early February. This capability and the lower turbulence levels compared with those of the Princeton tunnel could yield some interesting results. Remember the Princeton wind-tunnel test results on the SD8020 as compared with other sym-

VULCAN 2-METER

Brian Agnew holds the Mark-Allen-designed Vulcan 2M. With the S7012 airfoil, this model should be just the ticket for pilots who are looking for a 2-meter with a wide performance range.

With all the talk about the S7012, you're probably wondering where to buy a model that has this new airfoil? Expect to see it pop up in a variety of places as an alternative to the RG15—especially on unlimited ships. The S7012 design is intended for F3B models, but Mark Allen has built it into the Vulcan 2-meter. It works just fine on a 2-meter.

The Vulcan, available from Slegers International, has a one-piece wing and a V-tail, which makes it a very simple, lightweight model. With a straight center section and straight tapered tips, the planform is a little different from the current multitaper trend. In the mid-30-ounce range, the S7012 Vulcan flies with a wing loading of around 9.25 ounces per square foot. Ed Slegers experimented with an even lighter Vulcan, in the mid-20-ounce range, but with this lighter weight and lower speed, the S7012's performance starts to suffer. Ed says that he added some ballast to that model to return it to its normal weight, and now it flies much better.

Going down to a 2-meter model is always a step down in performance. Big models fly better. With the S7012, the Vulcan should be a nice small model for pilots who like faster airfoils

This wind tunnel was tuned and calibrated for a lengthy period in preparation for the testing program, which is now proceeding.

metrical airfoils? Near zero lift, the SD8020 had a negligible deadband, which made it attractive for use on tail surfaces. Surprise! There is a deadband near zero lift, although it's less than other comparable symmetrical airfoils.

I built the S7012 test model that has been tested and the RG15. The S7012 looks as though it should be the next hot airfoil on the scene. The first thermal kit with this exciting airfoil is the Mark Allen Vulcan from Slegers International*. Other pilots are giving the S7012 good field reviews. I've enjoyed flying the S7012 on a 60-inch slope ship and an F3B model. Now we need some competition results to see how it compares with the RG15 in competition.

The Princeton tests were in the Reynolds-number range of 60K to 300K. The UIUC results will expand this range going down to 40K and all the way up to 500K. This should produce better data for hand-launch fliers and F3B models. Test models can be as thin as 4 percent, so we might start to see some numbers on some free-flight airfoils that could be useful to the hand-launch fliers.

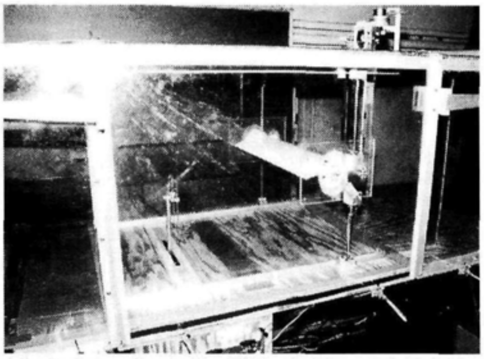
All of this and more will be published in an upcoming volume of "SoarTech," which is now in progress. In a worst-case scenario, Michael says that they should have the page proofs ready within two months. Given magazine timetables, it might be ready when you read this column. When the book becomes available, I'll include a note in my column, and you can send your request to: SoarTech, H.A. (Herk) Stokely, 1504 N. Horseshoe Circle, Virginia Beach, VA 23451; e-mail: herkstok @aol.com.

Of course, the fastest way to get the data is on the World Wide Web (WWW). You'll need access to the Internet and a browser, such as NCSA Mosaic or Netscape. The URL (universal resource locator or address) is http://uxh.cso.uiuc.edu/~selig, and it has information on the latest status of testing. Michael says they may even add an interface to analyze airfoils over the Internet from browsers that have "forms" support.

THE S9000 AIRFOIL SERIES

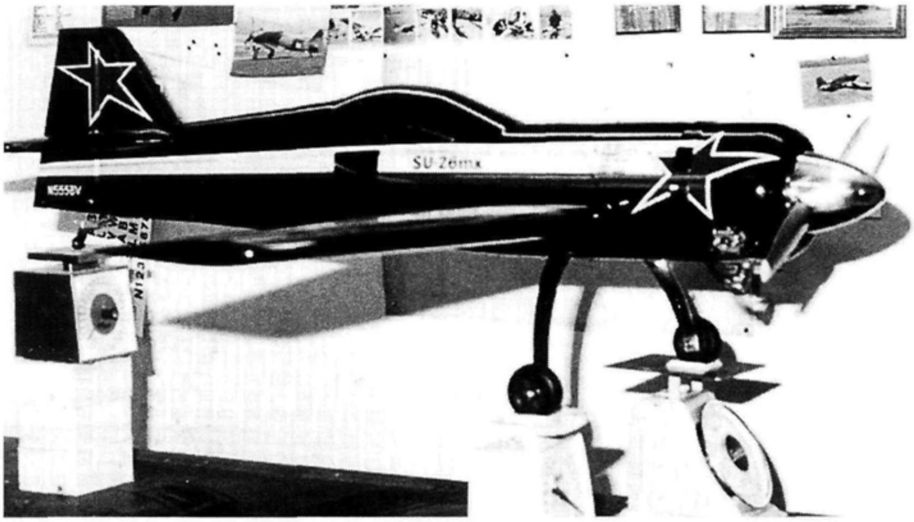
Michael Selig comments, "Several people have asked for coordinates (and performance data) for the S9037 airfoil used on the OPUS 750 standard-class and the S9000 on the Black Hawk open-class sailplanes. Both of these gliders and their airfoils were designed while I was still at Penn State—after the Princeton wind-tunnel tests and before the UIUC tests had been envisioned. The idea was, of course, to apply my experience in aero-engineering to generate some income in case I found myself unemployed, like many of my fellow graduate students and colleagues at the time. Fortunately, I did not have to depend on that income. The upshot of all this is (1) the airfoils are proprietary to the current manufacturers, (2) I am not able to release them, (3) the airfoils will not be wind-tunnel tested, and (4) your donations did not subsidize that work done at Penn State—work that people are only now becoming aware of since the gliders are only recently being produced. But for those who are patient enough, and should I decide to exercise a clause in the agreements, the airfoils can be released after 10 years from the date that the sailplanes were first made available. I will be very surprised if by that time someone else has not figured out how to clone the S9000 Black Hawk and S9037OPUS 750 airfoils."

You can support the test program by sending for a T-shirt, designed exclusively for the UIUC low-speed-airfoil test program by Cody Robertson of Flagstaff, AZ. This white, short-sleeve, 100-percent-cotton, Hanes T-shirt can be yours for a suggested donation of $18 ($15 for the shirt and $3 for mailing). Make your check payable to the University of Illinois, AAE Dept. Please write on the check: "Selig—Wind-Tunnel Testing/AAE Unrestricted Funds." Mail your order to the graduate student coordinator: Jim Guglielmo, c/o Michael Selig, Dept. of Aero. and Astro. Eng., University of Illinois at Urbana-Champaign, 306 Talbot Laboratory, 104 S. Wright St., Urbana, IL 61801-2935; work (217) 244-0684; home answering machine (217) 367-1960; fax (217) 244-0720; e-mail: jjgug@uiuc.edu.



The test chamber in the UIUC wind tunnel is 3x4x8 feet long. Photos by Michael Selig.

**Addresses are listed alphabetically in the Index of Manufacturers on page 130.* ■



PHOTOS BY JERRY NELSON

Weighing Bob Vaillancourt's Ultimatesport Sukhoi SU-26M on three scales to determine its CG.

Center of Gravity Considerations

by JERRY NELSON

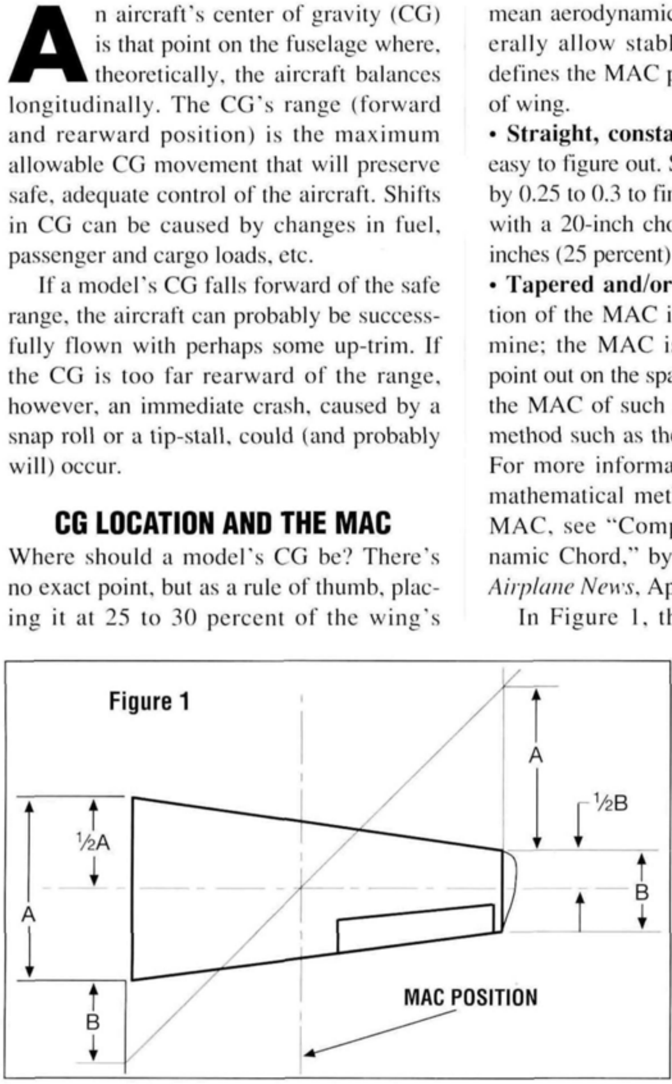
An aircraft's center of gravity (CG) is that point on the fuselage where, theoretically, the aircraft balances longitudinally. The CG's range (forward and rearward position) is the maximum allowable CG movement that will preserve safe, adequate control of the aircraft. Shifts in CG can be caused by changes in fuel, passenger and cargo loads, etc.

If a model's CG falls forward of the safe range, the aircraft can probably be successfully flown with perhaps some up-trim. If the CG is too far rearward of the range, however, an immediate crash, caused by a snap roll or a tip-stall, could (and probably will) occur.

CG LOCATION AND THE MAC

Where should a model's CG be? There's no exact point, but as a rule of thumb, placing it at 25 to 30 percent of the wing's mean aerodynamic chord (MAC) will generally allow stable flight. The following defines the MAC positions of various types of wing.

- **Straight, constant-chord wings.** This is easy to figure out. Simply multiply the chord by 0.25 to 0.3 to find the correct CG. A wing with a 20-inch chord will have its CG at 5 inches (25 percent) from its leading edge.
- **Tapered and/or swept wings.** The location of the MAC is more difficult to determine; the MAC isn't simply the halfway point out on the span. The easy way to figure the MAC of such a wing is with a graphic method such as the one shown in Figure 1. For more information on the graphic and mathematical methods of determining the MAC, see "Compute the Mean Aerodynamic Chord," by James McClure, *Model Airplane News*, April '92.



In Figure 1, the MAC falls less than halfway out on the wing's span. If we want the CG at 30 percent of the MAC of the tapered wing, we simply locate the MAC on the wing, determine the cord length at that point, then multiply that chord by 0.3. The resulting dimension is the CG location from the leading edge at the MAC.

- **Biplanes.** A bipe's optimum CG location is somewhat difficult to determine without flight tests. For one reason, the efficiencies of the top wing and the bottom wing are not the same. The top wing is usually separate from the fuselage, and the bottom wing is usually built into the fuselage. A good rule of thumb is to place the CG at a point between the top wing's MAC and the bottom wing's MAC at 75 percent up from the bottom wing. This line is drawn between, for example, the 25-percent points of the wings' MACs. This assumes that both wings have the same wing area. If the bottom wing has less area, the CG should be moved upward proportionally. It doesn't matter whether the wings are staggered; simply draw a line between the leading and trailing edges of the MACs and place the CG along this line.

CG PLACEMENT AND ITS EFFECTS

A CG that's more toward the rear of the aircraft will increase the sensitivity and effectiveness of the elevator and usually improve the aerobatic capability of the model. A forward CG creates the opposite effect.

A CG that's too far to the rear increases the chance of unwanted snap rolls at slow speeds, especially in turns. It also makes it difficult to trim the model for level flight, especially when fuel is low. Additionally, it can sometimes be difficult to find the right elevator setting for good landings, and a turning motion can occur during roll maneuvers. Spins can be exciting with rearward CGs; recovery can be marginal and perhaps impossible. If the model doesn't want to come out of a spin, it's best to give it down-elevator. That will usually stop the spin immediately. If you recover too quickly, watch out for a secondary spin. When the model has trouble coming out of a spin, pull out gently.

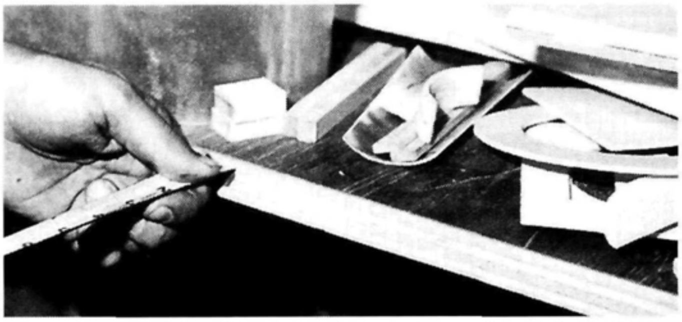
If the CG is too far forward, you might

not have enough up-elevator to land properly. Increasing the elevator travel doesn't solve this; elevator effectiveness doesn't increase after 25- to 30-degree deflections. The airplane will fly adequately at medium and high speeds, but slow speeds will require a lot of up-trim, and landings will be difficult when you run out of up-elevator response.

ADDITIONAL CG CONSIDERATIONS

Several factors that affect how critical the CG location is:

• **Stabilizer/elevator size.** The larger the stab/elevator, the more freedom you have with the CG location. If the stab/elevator area is less than approximately 18 percent of the wing area, the CG will have to be farther forward, perhaps to 25 percent MAC or even less. Stab/elevators with areas of 20 to 25 percent of the wing area work well for models.



Measurement to the model's axles is made from a fixed point in front of the aircraft; a nearby shelf was used.

• **Stab placement.** Stabs with longer moment arms make CG placement less critical. Consequently, the stab can be smaller.

• **Vertical fin/rudder size.** To a certain extent, the size of the vertical fin/rudder affects the sensitivity of the CG position.

• **Wing incidence.** For most models, no more than 1½ degrees of difference between the center lines of the wing and the stabilizer is ever needed. Models don't need as much incidence (or dihedral) as full-scale aircraft. Models generally need to be more maneuverable—actually, more unstable—so that they can perform better aerobatics—even aerobatics that the full-scale aircraft can't perform. (Big argument here: I believe that we point our R/C models, we don't fly them. We disturb them from one stable position to another. In this manner, we are flying our models.)

• **Radio system.** A radio system and, in particular, an elevator servo with an excessive dead band (error around neutral) will require a much more critical placement of the CG. The dead band forces the pilot to "hunt" for a neutral setting during flight, especially at high speeds. Hands-off, the model won't fly level; it will always be climbing or diving slightly. A high-performance servo and additional nose weight can help to keep the model flying level at higher speeds.

OTHER CG CONSIDERATIONS

One advantage of models over full-scale aircraft is that models usually have a fixed CG. Other than the weight of the fuel, the model's weight and the CG really don't change too much. Consider the design of an airliner. The passenger, cargo and fuel loads vary considerably from flight to flight. Giant-scale models with 24- to 32-ounce fuel tanks could have a CG-shift problem when the tank goes from full to empty. A 24-ounce tank holds almost 1 pound of fuel. You should consider both the forward-CG (full tank) and the rearward-CG (empty tank) positions when you use large gas tanks.

On airliners, notice the length of the fuselage and how large the stabilizers are. The six-place Cessna 310 and the Beechcraft Baron have huge stabilizers—maybe over 40 percent of MAC.

Because the CG never changes on sailplanes (except for the water ballast, which is usually in the wing, on the CG) they have tiny stabilizers—less than 10 percent sometimes. Increased drag and weight are the disadvantages of using big stabilizers. Excess weight in the tail drastically affects the CG. One extra ounce of weight in the tail usually requires about 3 ounces in the nose (depending on the nose- and tail-moment arms)—a total of 4 extra ounces. An ounce saved in the tail decreases the total weight of the aircraft by 3 to 4 ounces.

While you install the equipment and cover and paint your model, you should constantly consider the CG location; it's a lot easier to change it before the model is finished. If the model is coming out tail-heavy, you may want to consider building a lighter tail group, or perhaps you'll be very careful when covering and painting the tail group. Maybe the nose should be lengthened, or you should add a little extra material to the nose/firewall area to balance the heavier tail.

Full-Size Aircraft CGs

The CGs of full-scale aircraft are usually at about 25 percent of the wing's mean aerodynamic chord (MAC). The Cessna Cardinal's CG is at 5 percent of MAC. The original aircraft had trouble with elevator control during low-speed flight and landings. The far forward CG location was a result of Cessna's advertising department wanting the pilot forward of the high wing so that he'd be able to see out better. The ad people weren't concerned about the CG problem.

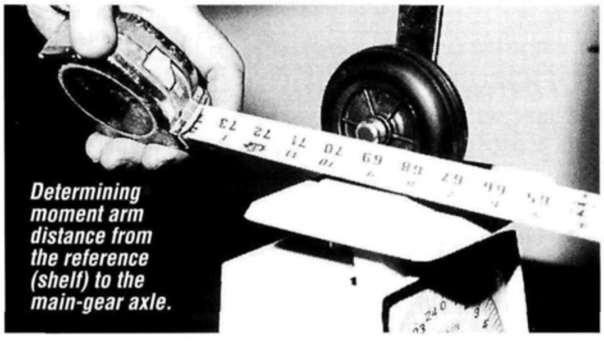
One of the Russian jet transports has a rear CG of 40 percent; the huge C-5A transport has a limited CG of about 25 percent. The latest series of jet fighters is extremely maneuverable on the pitch axis (elevator control), but a computer is necessary to fly the aircraft straight and level. Pilots can't hand-fly the newer jet fighters because they're tail-heavy in the normal sense.

DETERMINING CG OF A BUILT MODEL

If the model has already been built, how do you determine the CG? Usually, you simply pick the model up by the wingtips or the fuselage with your fingers, move your fingers around until the model is balanced level, and there's the CG. No big deal.

Some giant-scale models, however, are too large, awkward, or heavy for conventional methods. An easy and accurate way to find the CG of giant-scale models is to place each wheel on a separate weighing scale. The distances between the main-gear wheel axles and the tail-wheel axle on the scale must then be determined. This is done by measuring a fixed point, usually somewhere in front of the airplane. The force moments of the moment arms and weights are determined, and the resulting CG position can be easily calculated.

If balanced perfectly, a 20-pound model with a two-wheel main gear exactly on the CG will show no weight on the tail-wheel scale and 10 pounds on each of the two scales that support the main



Determining moment arm distance from the reference (shelf) to the main-gear axle.

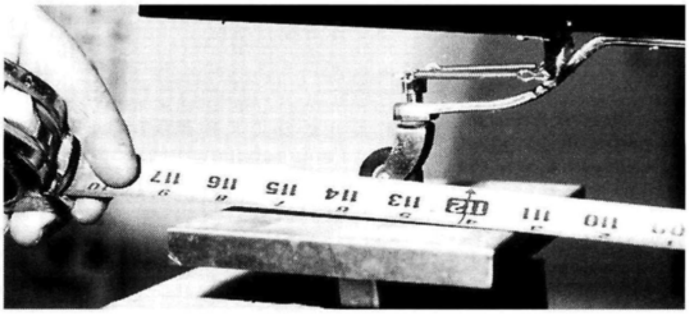
wheels. If you move the landing gear forward, weight will be added to the tail-wheel scale, and the weight on the landing-gear scales will be reduced. The resulting calculations will show the CG behind the main gear.

The accompanying photographs show the weighing of Bob Vaillancourt's (Reno, NV) Ultimatesport R/C* Sukhoi SU-26M. The CG was determined with the gas tank about half full and the smoke tank empty. The calculations for the Sukhoi are shown in the chart with the resulting CG. The three scales were blocked up to make the fuselage level. In Bob's workshop, we used the edge of a shelf as the forward reference point. We could have used the back of the propeller for a reference but, in doing so, there's a significant chance of measurement error. Using a more forward reference increases the accuracy.

The CG of the Sukhoi is 72.15 inches from the edge of the forward reference point (the shelf). Another way to determine this dimension is to measure the distance from the leading edge of the wing to the edge of the shelf; this equals 68.02 inches. Then, subtract the 68.02 inches from the computed CG, which is 72.15 inches from the shelf. The difference is 4.12 inches. This is the distance from the leading edge of the wing to the computed CG location.

Make a scratch mark on the bottom of the fuselage to indicate the CG position for future reference. In this case, it's about ⅛ inch behind the Sukhoi's CG, as recommended by the manufacturer, and that's close enough.

Use a 90-degree square to measure up to bottom of fuselage to mark calculated CG position.



Determining moment-arm distance from the reference (shelf) to the tail-wheel axle.

FIXING CG PROBLEMS

What do we do if the CG is not where the design specifications indicate that it should be? Don't just go ahead and fly the model and see what happens. As I mentioned before, a CG that's forward of the designated position is not too critical, but if the model's CG is behind the recommended point, or if the model is an un-proven design with its CG more than a ⅓ back, do something about it. Here are some suggestions:

- Move the battery pack(s) as far forward as possible. Perhaps the servos can be moved forward. Use lighter elevator and rudder pushrods. How about a lighter tail-wheel assembly if your plane is a tail-dragger? Can the engine be moved forward of the firewall with the use of spacers?
- It's often impossible to do anything about the radio/servo installation positions. There are times, however, when you can do something, but at the cost of added weight. Adding weight is not desirable, but a tail-heavy airplane that has crashed isn't worth much either. Many full-scale aircraft have ballast. The Beechcraft Bonanza has about 30 pounds of lead attached to its firewall. The P-51 has a tail-wheel assembly that's unusually far forward to allow about 500 pounds of lead to be attached where the bottom of the vertical fin-spar assembly is attached to the fuselage.
- When you have to add weight, try to get some additional benefit from the extra weight, e.g., use a larger battery pack; the extra battery capacity will improve the performance of the radio system. How about a smoke system? If you can put the pump and tank in the nose, the added weight may fix the CG while the smoke system provides more flying fun.
- You may be able to use spacers to extend the engine out from the firewall. You could also make the engine extensions, spacers, or shims out of steel or brass instead of lighter aluminum or hardwood.
- If a battery ignition system is employed, install the batteries under the engine with a suitable bracket assembly. Larger ignition batteries will also add weight to the nose. If the model has a glow engine, why not add an ignition system? Install the system as far forward as possible. The engine will have the same power, but it will be easier to start (especially if it's a 4-stroke engine), and the idle will be drastically improved both by a lower idling speed and improved reliability.
- Consider adding an electric starter system for the engine. Hobby Lobby* makes an excellent unit. Starter systems weigh about 1 pound without batteries. Batteries weigh about 1 pound. You can keep the batteries outside the plane and just plug them in to start the engine. I hope to do this on my next AL-1 airplane.
- If you aren't using a spinner, add one. If you are, switch to a heavier one. Add a heavy prop nut. You can also make a large steel or brass nose weight that is enclosed inside the spinner. I did this on my AL-1 aluminum airplane. The 13-ounce weight fits inside a 3-inch-diameter spinner.
- If the aircraft design permits it, install a larger, heavier engine. You don't have to use all the horsepower that's available, but you probably will!

Whatever you do, don't fly the model with a CG that's too far back. Add the nose weight. Later on, experiment by removing some of the nose weight, and see what happens. You might be able to fly the model satisfactorily with the rear-ward CG.

**Addresses are listed alphabetically in the Index of Manufacturers on page 130.* ■

Sukhoi CG Calculations

Scale weights (oz.)	Moment arm (in.)	Moment (oz.-in.)
140 (left wheel)	69.25	9,695
138 (right wheel)	69.25	9,556.5
19.5 (tail wheel)	113.5	2,213.25
Total weight: 297.5	Total of moments: 21,464.75	

Center of gravity = total of moments÷total weight = 21,464.75÷297.5 = 72.15 in.

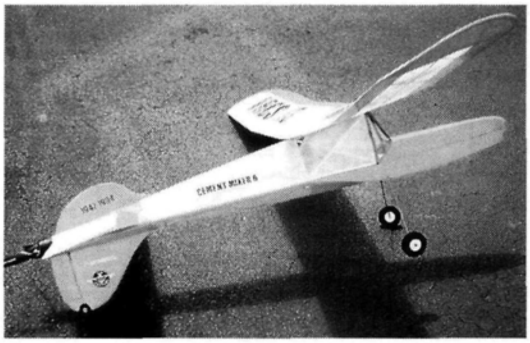
GOLDEN AGE

HAL DEBOLT

EARLY PULSE CONTROL AND THE "GALLOPING GHOST"

THIS IS THE 101st edition of this column, so it seems safe to assume that we have covered one lot of history, yet your interest indicates that we've hardly cracked the shell. Remember, this is your OT R/C place and your R/C experiences are always welcome.

For instance, Bob Noll of Vestal, NY, tells us about building a Fred Dunn-designed Astro Bipe. Did you even know there was such an Astro two-winger? John Worth tells us how he recently found out that Fred is an active member of a local free-flight group and that Fred has extensive, accurate drawings of his Astro Bipe for sale. Sorry, no address, but perhaps Fred will read this and pass the needed info along to us.



John Worth's electric-powered replica of his '40s-era Cement Mixer. The pusher prop at the end of the extension shaft is an example of the unusual seen at the '94 Selinsgrove meeting.

HOG HEAVEN

We've recently been speaking of Hog designs, and Tom Gealta of Tampa, FL, phoned to tell us that he has a Smog Hog kit and hopes to use it soon. Robert Gill of Richmond, VA, wrote that he built a Smog Hog from a kit in 1958, and it is still flying! To top it all off, Clarence Lee (yes, *the* Clarence) of Sunland, CA, tells us that he thoroughly enjoys the "Golden Age of R/C." He also recounts that it was Veco that kitted the Smog Hog, and it became one of their best sellers. This fact explains the multitude of Hogs we saw on the '50s flight lines. Strange that I did not recall the kit!

More Hog news comes from Fred Dustin of Saugus, MA, whose first R/C airplane was either a genuine Smog Hog or a Guillow Explorer—a Lou Andrews takeoff of the Hog. Fred would like to duplicate his first plane and needs plans, so I'm pleased to say that Tom Dixon lists Smog Hog plans (address in "Low-Wing Advantage" sidebar).

ACHIEVING CONTROL

We heard from Roy Clough of Pittsfield, NH, whose interesting input will be of particular value to those who were involved with the Galloping Ghost systems back in the '50s. Roy Clough is one of the old OT'ers, having modeled since the early '30s. His major interests have always been FF and CL, which he has reported on in many major magazines. In the late '40s, he developed some FF helicopters for Bill Effinger and Berkeley Models. Because of this connection, when Berkeley produced the Aerotrol, Roy was asked to evaluate the R/C

LOW-WING ADVANTAGE

If the Astro Hog indicated the value of the low wing to R/C, the first World Champs at Zurich established its superiority in pattern competition.

One modeler's modern replica of the Orion—still a good-looking plane.

Of the approximately 30 entries in the Champs, only about five were of the low-wing variety, but these five dominated all.

When thinking of this event, the name that comes to mind first is Ed Kazmirski. Ed had an Astro Hog that impressed him so much that he began to experiment with low-wing configuration. The Astro is a sizable airplane, but Ed believed that something smaller might be superior. Thus, his drafting board gave birth to the Orion, which proved his theory by becoming the world champ.

If the Orion was a step forward, Bob Dunham's Voltswagon was a giant leap ahead! Though Bob was handicapped by engine problems at the Champs, later performances, such as his world-class domination of the Detroit Invitational, revealed the Volt's outstanding capability.

Left to right: Kazmirski and his Orion, deBolt with his bipe and Dunham with the Voltswagon at the Detroit Invitational; Dunham won it easily.

I'd suggest that you take a close look at

aspect. To get a feel for its R/C operation, he built an ultra-simple model of the Aerotrol using the common elementary escapement for rudder control. On flying it, Roy thought it was easier to steer his full-scale Tri-Pacer than it was to keep up with the "beeps" that guided the model!

Roy and Bill Effinger contemplated the situation and decided that a different sort of control action might be easier to use. They called the "tab" that was used as a control surface, the "spoon," because it resembled a large spoon. Initially, this was attached to a free-turning shaft so that the air stream caused it to spin. A 2-position escapement activated a catch that stopped the spoon for a right or left reaction. The major advantage of this mechanism was that no rubber-band power was needed. Test flights proved scary; there was no neutral, and you never knew in which direction the spoon would stop!

They knew there had to be a better way—perhaps using a 4-position escapement. In those very early times before Bonner, multiple-position escapements were common. Roy thought that he could stop the "spoon" in any of the four positions to allow the addition of elevator action to the single-channel Aerotrol—eureka! These early models were set up to climb constantly, so all the down-elevator position did was create level flight. Thus, Roy was able to find his elusive "neutral." From this down-neutral position, one "beep" would move the escapement to its first stop, and the spoon would create a right turn. The next stop would be up on the spoon, and the third would be a left turn. These were not self-neutralizing escapements, so four beeps were required to get from down neutral back to where you started. Otherwise, you had to know where the spoon was before you initiated a different action. Also, the signal had to be correct and on time. If it wasn't, the escapement could skip right past the desired position.

The model went merrily on its way; no wonder slow flight was a requirement. It should be obvious that with one control surface providing four actions, as you cycled through the positions to what you wanted, the model reacted to each one. This caused considerable tail-wagging, which could, indeed, be described as "galloping!"

WHAT'S IN A NAME

Of course, the label "Galloping Ghost" was applied to the much later "pulse" systems, which featured a mechanical linkage to obtain elevator control from the normal rudder actuator. With this system, the pulsing signal switched the voltage on the actuator motor, causing it to rotate in one direction, then the other. When either positive or negative was held on longer than the other, the motor would cause the control surface to move in that direction, i.e., the one that was held on longer. As you can imagine, to have positive action, the pulse rate had to be kept rather slow. Now mechanically add an elevator to the pulsing network and you'll see some really fancy tail-wagging—just what we wanted! Lord only knows who labeled it "Galloping Ghost," but they sure hit the nail on the head! In due course, persistent experimenters were able to increase the pulse rate until the tail-wagging was hardly visible. But, then along came "reeds" to make everything so much simpler....

The bottom line is that Roy Clough jokingly believes he might have been "galloping ghosting" long before the term was concocted.

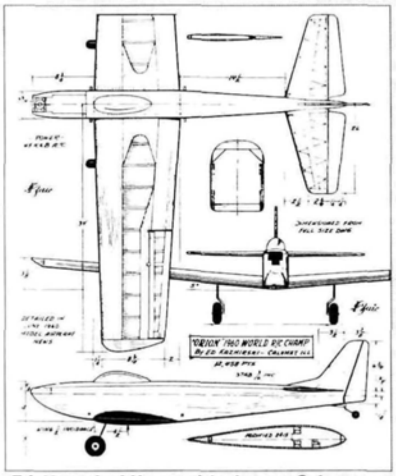
HONORABLE ESQUIRE

Once again, it seems fitting to take a moment to pay our respects to another of our generation who has passed on.

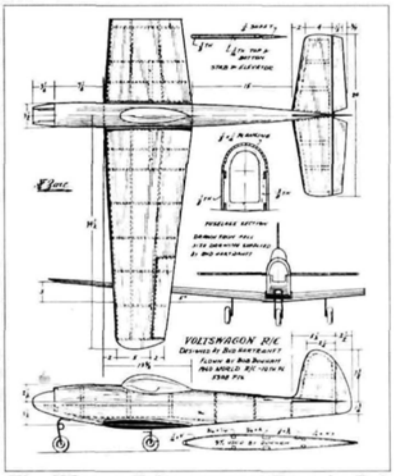
the Voltswagon 3-view. Can you believe the design is really 30 years old? Much of what you see was completely new at the time and was considered radical! The design's aerodynamics are still used today. Obviously, the fully symmetrical airfoil proved its worth. Not only was there a tricycle gear but, as now, the nose gear was steerable!

Clarence Lee tells us that his early R/C cohorts were Howard Reed and Bud Hartranft. These visionaries drew on their extensive CL experience to co-design the Voltswagon. Unfortunately, neither is still with us.

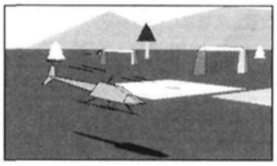
Both Orion and Voltswagon plans are available from Tom Dixon at P.O. Box 671166, Marietta, GA 30066.

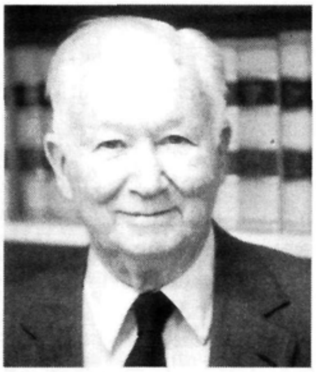


Ed Kazmirski's world champ Orion was kitted by Top Flight (Zaic drawing).



The '60s-era Voltswagon as flown by Bob Dunham (Zaic drawing).

The late Jeremiah Courtney was our longtime liaison with the FCC.

This time, it's someone whom you probably would never have rubbed shoulders with at a flying field, but he was largely responsible for your being able to fly R/C.

As John Worth suggests, 30 years ago we had frequency problems that seriously affected the flying and the future of R/C; help was sorely needed. Obviously, the problem was alleviated, because today we have approximately 50, mostly trouble-free channels. You can imagine what a chore this must have been to achieve while working with the bureaucratic FCC.

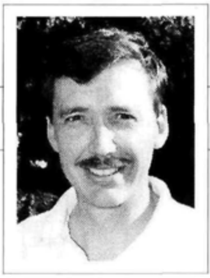
When the AMA (with John Worth at the helm) looked for help, they found a most cooperative attorney in Jeremiah Courtney. Jerry, as he preferred to be called, was renowned for representing numerous major organizations to the FCC. His was a lifelong effort.

When Jerry came aboard, it was obvious that our issues with the FCC would be time-consuming. In fact, our association with the FCC continued for nearly 30 years, changing in our favor a bit each decade. To Jerry's credit, he was sympathetic to the fact that we didn't have nearly as much clout as the major corporations he usually worked with. As a result, we received excellent representation and much-needed help at a very nominal cost. We appreciated his concern!

Jeremiah Courtney left us last November at the age of 84, leaving a legacy that allows upwards of 250,000 R/C'ers to enjoy their sport. Our hats are off to a fine gentleman.

So be it, until next time! ■

SIMPLE PROGRAMMING



DAVID C. BARON

JR PCM-10SX

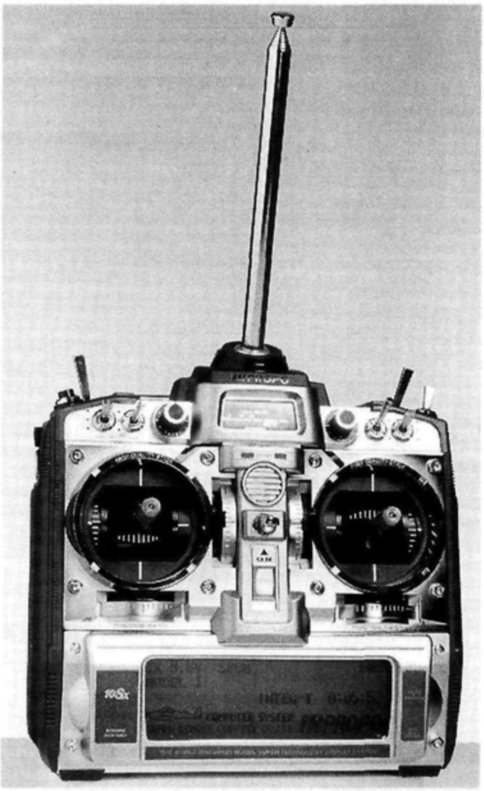
NOT EVERY MODELER feels the need for a top-of-the-line radio, yet many situations and applications require this level of quality. I have seen my share of museum-quality models, with thousands of hours of labor spent on them, flown with radio equipment that is obsolete or inadequate for the task. Eventually, this scene can spell disaster for a beautiful plane. All may be lost because the builder cuts corners on equipment, even though that modeler would never consider making the smallest exception in the construction of his plane.

WHO NEEDS IT?

Let's consider the types of model that qualify for this level of radio. In scale, highly complex aircraft are appearing at contests across the country. There seems to be a growing attitude that anything that you can imagine can be built and flown. Consider the F-117 Stealth Fighter that received so much press in the last year. If we had believed the Air Force, no one would have tried to fly a model of it because the full-scale aircraft is said to be unstable, and it requires a computer to help the pilot fly. Although the model turned out to be a stable flier, its complex functions require the use of a programmable radio and nine channels (several of them interactive) to achieve a satisfactory flight-control system. (See May '95 issue's "Final Approach" column.)

Today, scale model aircraft are commonly fitted with retracts, slotted flaps, brakes and multiple engines. When feasible, the savvy pilot automatically ties these functions to other channels and functions so that they are byproducts of pre-programmed conditions, e.g., flaps may automatically be deployed when retracts are extended *and* throttle is cut.

The capability of many of today's models to drop or deploy any number of objects is almost as common as the traditional Piper Cub itself. Speaking of Cubs, even that venerable aircraft can be made



SPECIFICATIONS JR PCM-10SX

- 10-channel PCMS, PCMZ, or PPM selectable computer radio
- 10-model memory
- 8 programmable mixes, three of which are multi-point programmable
- User-friendly programming using soft-touch screen
- Servo-speed programmability
- 3-axis rate selectivity
- Supports five wing types: vee-tail, flaperon, elevon, quad-flap and normal.

still easier to fly through the proper application of mixing functions. For example, if you are trying to win a scale contest, functions such as aileron differential reduce pilot workload and permit concentration on completing the maneuvers and tasks at hand. If you're sneering at what I just said, take a trip to the local airport and ask an A&P about rigging the ailerons of any full-scale aircraft and how much differential is required for the various aircraft.

Pattern jockeys know how useful all the mixing features are in the top-of-the-line radios. One common application is a mix that helps the pattern ships' vertical up and down lines stay perfectly straight. These mixes are coupled with throttle so that the elevator and trailing edge of the wing get different trim compensation at different throttle settings.

THE JR PCM-10SX

Here are a few samples of what I feel are the neatest features of this JR* PCM, 10-channel programmable radio. There is not enough space in this entire issue to do justice to its features and capabilities.

• **Multi-point programmable mixing**. This feature has long been available in helicopter radios, but it has many applications in fixed-wing mixes. Many pilots use mixing to compensate for pitch and roll changes when varying amounts of rudder deflection are used for knife-edge flight. The problem is that the proper amount of compensation in pitch and roll varies with the amount of rudder throw. With the multi-point mixing, you establish how much mixing takes place at each of seven different points in the motion of the master channel (rudder, in this case).

• **Include mixing.** This is the capability to "cascade" your mixes together. It ultimately allows you to perform multiple (or complex) mixes, all being driven by the same master channel. The advan-

tage is that you can use only two mixes in a situation that, without this function, would have required three mixes.

• **Touch-screen control.** This is great for keeping dust and dirt out of your radio. Most other computer radios rely on buttons and rocking switches. These are open invitations to moisture, dirt and other contaminants that can enter and degrade your radios.

• **Function code system.** Rather than using abbreviated plain language, the list of functions relies on a number system. The disadvantage of this is that access to the functions is through the code numbers; if you step through every page of codes manually, you'll see a display of the function names. The advantage is that certain like functions are grouped.

• **Dual rates, expo and VTR.** The elevator, rudder and aileron dual-rate systems all have three positions. This is handy not only for the veteran who knows exactly what he wants, but also for the experimenter who wants to try something different at each switch position. You can take advantage of any combination of dual rates, exponential and the variable trace rates in any of three switch positions. Hence, you can explore the full value of each function, or any combination of these functions, and then choose your preferred mix of values for each of the three switch positions.

• **Throttle exponential.** Throttle exponential has a neat feature that allows you to set either the bottom end of throw (called LO-Base) as the exponential area or to select the mid range as the area of throw to be stretched (or compressed).

• **Sub-trim feature.** If you are close to maximum throw value in your ATVs (adjustable travel volumes, also known as endpoint adjustments), sub-trims should be used with care, because you can run out of servo motion before you reach the limit of stick deflection. Subtrims are available on all 10 channels.

• **Trimmer function.** Trim function is inaccurately named because it leads the user to think that it is part of a function used in setting the trim of the plane for flight. In fact, it is the trimmer function, and with this, you assign the function of various trim levers to their master control sticks or knobs. For instance, if you use flaps as a mixed, "automatic" function or a function on a switch, you can defeat the operation of the left-hand slider, which normally controls the flap function. This way, you would not upset your plane's trim by inadvertently displacing this lever. If you use any of the elaborate wing configurations that can, for instance, control variable camber, you can assign individual trim capability for each independent control surface on the wing.

You also set the throttle and elevator for cross trim or normal function—"normal" being that the elevator trim is next to the elevator stick, and "crossed" is placing the elevator trim next to the throttle stick and, likewise, the throttle trim next to the elevator stick.

Sample of JR PCM-10SX Code Functions

Code #	Display	Program description
11	Reverse SW	Servo-reversing switches—all channels
12	Travel adjust	Endpoint travel adjustment—all channels
13	D/R and exp.	Dual rate and exponential adjustment elev./aileron-/rudder/throttle adjustments
14	Trace rate	Affects total throw of both servos when the master channel is either aileron, elevator, or rudder
15	Sub-trim	Electronic means of centering all channels
17	Trimmer function	Cross trim throttle and elevator, flap, auxiliary 2, and auxiliary 3 switches and levers can be activated or inhibited
18	Pitch control	Variable-pitch propeller mixing
22	Wing type selection	Normal, flaperon, elevon, quad flap and vee-tail mixing

Code #	Display	Program description
24	Servo speed	Servo speed adjustable for all 10 channels
28	Data reset	Individual program erasure and reset
31	Snap roll	Snap-roll adjustment and switch position
48	Auto dual rate	Auto rudder dual rates
51-55	Program mix	Program mixing selection and adjustments
56-58	Selectable multi-point program mix	Up to 7-point programmable curve can be programmed
63	Elevator-flap mix	Elevator to flap mixing
66	Landing system	Adjusts the aircraft's landing attitude for more consistent landings
67	Gear slow U/D	Retractable landing gear operating speed
75	Servo test	Servo test—slow and step
77	Fail-safe	Fail-safe memory and settings
81	Model name	Model name memory input
82	Trim offset	Trim offset correction adjustments
83	Trim rate	Trim travel authority selection and adjustments in 1% increments
84	Model select	Model memory selection (1–10)
85	Modulation	Modulation selection (SPCM, ZPCM, PPM)
86	Data transfer	Model memory transfer to/from another PCM 10SX
87	Timer	Countdown timer and TX on time reset
88	Keyboard lock	Keyboard lock password selection

CONCLUSION

Among the top-of-the-line radios that I have had the pleasure of reviewing, this one certainly stands out. It is complete without being over-engineered. What sets it apart from its competitors is the feeling that pilots rather than computer engineers headed the design team. It takes no time at all to become comfortable using its many features.

Hits

• Easy-to-use manual with many practical application examples.
• Logical programming system that is flexible without being complex.

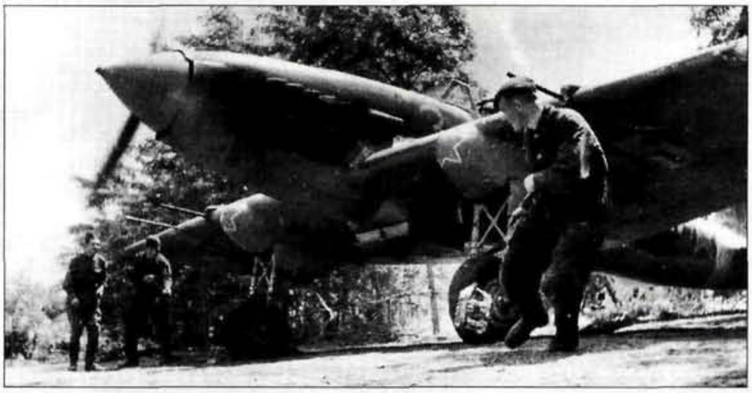
Misses

• Output-level meter is no longer an RF meter; it is merely a voltmeter.
• In these days of inexpensive computer memory, I would have expected JR to include the helicopter mode functions in this radio.

*Addresses are listed alphabetically in the Index of Manufacturers on page 130. ■

NAME THAT PLANE

CAN YOU IDENTIFY THIS AIRCRAFT?



If you can, send your answer to *Model Airplane News*, **Name That Plane Contest** (state issue in which plane appeared), 251 Danbury Rd., Wilton, CT 06897.

CONGRATULATIONS to Bill Winkler of Ocala, FL, for correctly identifying the April '95 mystery plane. The Vought XTBU-1 Sea Wolf three-place torpedo bomber first flew on December 24, 1941. It was in competition with the Grumman TBM/TBF Avenger for a Navy contract to supply torpedo bombers, but it lost.

Approximately 189 aircraft were produced after the design was sold to Consolidated Aircraft, who re-designated it the TBY-2 Sea Wolf. Powered by a Pratt & Whitney R-2800, 2,000hp radial engine, the Sea Wolf had a top speed of 311mph at 14,700 feet, and it had a ceiling of 27,200 feet. The 39-foot, 2½-inch-long plane had a 56-foot, 11-inch wingspan and a range of more than 1,500 miles. ■

The winner will be drawn four weeks following publication from correct answers received (on a postcard delivered by U.S. Mail), and will receive a free one-year subscription to **Model Airplane News**. If already a subscriber, the winner will receive a free one-year extension of his subscription.

INDEX OF MANUFACTURERS

Ace R/C Inc., 116 W. 19th St., P. O. Box 472, Higginsville, MO 64037-0472; (816) 584-7121; fax (816) 584-7761.

Aerrow Inc.-Quadra, P.O. Box 183, 1881 Rogers Rd., Perth, Ontario, Canada, K7H 3E3; (613) 264-0010; fax (613) 264-8441.

AI/Robotics, 1440 Third St. Unit 4, Riverside, CA 92507; (818) 892-9671; fax (818) 837-4201.

APC Props; distributed by Landing Products, P.O. Box 938, Knights Landing, CA 95645; (916) 661-6515.

Associated Electrics, 3585 Cadillac Ave., Costa Mesa, CA 92626-1403; (714) 850-9342; fax (714) 850-1744.

Astro Flight Inc., 13311 Beach Ave., Marina Del Rey, CA 90292; (310) 821-6242; fax (310) 822-6637.

Avonds; distributed by Aeroloft, 130 W. Hampton, Ste. 20, Mesa, AZ 85210; (602) 649-8662.

Bob Banka's Scale Model Research, 3114 Yukon Ave., Costa Mesa, CA 92626; (714) 979-8058.

Bob Violett Models (BVM), 170 S.R. 419, Winter Springs, FL 32708; (407) 327-6333; fax (407) 327-5020.

Byron Originals, P.O. Box 279, Ida Grove, IA 51445; (712) 364-3165; fax (712) 364-3901.

Calandra Racing Concepts, 6860 Stanwix Ave., Rome, NY 13440; (315) 338-0867; fax (315) 338-0867.

Carl Goldberg Models, 4734 W. Chicago Ave., Chicago, IL 60651; (312) 626-9550; fax (312) 626-9566.

Cox Hobbies, 350 W. Rincon St., Corona, CA 91720; (909) 278-1282; fax (909) 278-2981.

Davis Model Products, P.O. Box 141, Milford, CT 06460; (203) 877-1670.

Du-Bro Products, 480 Bonner Rd., P.O. Box 815, Wauconda, IL 60084; (708) 526-2136; fax (708) 526-1604.

Dremel, P.O. Box 1468, Racine, WI 53406-1468; (414) 554-1390; fax (414) 554-7654.

Dynaflite, P.O. Box 1011, San Marcos, CA 92069; (619) 744-9605; fax (619) 744-7923.

Dynamax; distributed by Jet Model Products (see address below).

Fiorenze Hobby, 420 W. SR 434, Winter Springs, FL 32708; (407) 327-6353.

Futaba Corp. of America, P.O. Box 19767, Irvine, CA 92713-9767; (714) 455-9888.

Herr Engineering Co., 5648 Kingman Ave., Portage, IN 46368; (219) 759-1940.

Hitec/RCD Inc., 10729 Wheatlands Ave., Ste. C, Santee, CA 92071-2854; (619) 258-4940; fax (619) 449-1002.

Hobby Lobby Intl., 5614 Franklin Pike Cir., Brentwood, TN 37027; (615) 373-1444; fax (615) 377-6948.

Jet Hangar Hobbies, 10595 Bloomfield Ave., Los Alamitos, CA 90720; (310) 493-1285; fax (310) 493-1765.

Jet Model Products, 211 N. Mullen Rd., Belton, MO 64012; (816) 331-0356.

JPX; distributed by Bob Violett Models (see address above).

JR Remote Control; distributed by Horizon Hobby Distributors, 4105 Fieldstone Rd., Champaign, IL 61821; (217) 355-9511.

K&B MFG., 2100 College Dr., Lake Havasu City, AZ 86403; (602) 453-3579.

KBV; distributed by K&B MFG (see address above).

Klett; distributed by Carl Goldberg Models (see address above).

Likes Line, 1601 Airport Dr., Mechanicsburg, PA 17055; (717) 732-0636; fax (717) 732-0636.

Loctite Corp., 18731 Cranwood Ct., Cleveland, OH 44128.

Master Airscrew; distributed by Windsor Propellor Co., 3219 Monier Cir., Rancho Cordova, CA 95742; (916) 631-8385; fax (916) 631-8386.

Model Electronics Corp., 6500 6th Ave. NW, Seattle WA 98117; (206) 782-7458; fax (206) 782-9199.

MonoKote; distributed by Great Planes Model Distributors, P.O. Box 9021, Champaign, IL 61826-9021; (217) 398-3630; fax (217) 398-0008.

Nelson Competition Engines, 121 Pebble Creek Ln., Zelienople, PA 16063; (412) 538-5282.

O.S.; distributed by Great Planes Model Distributors, P.O. Box 9021, Champaign, IL 61826-9021; (217) 398-3630; fax (217) 398-0008.

Paul Appelbaum, 2232 Riverwood Trails Dr., Florissant, MO 63031; (314) 839-0486.

Peak Performance, 23352-J Madero Rd., Mission Viejo, CA 92691; (714) 707-4683; fax (714) 707-4684.

Ramtec; distributed by Aeroloft, 130 W. Hampton, Ste. 20, Mesa, AZ 85210; (602) 649-8662.

Robart Mfg., P.O. Box 1247, St. Charles, IL 60174; (708) 584-7616.

Robinson Racing Products, 4968 Meadow View Dr., Mariposa, CA 95338; (209) 966-2465; fax (209) 966-5937.

S&K Racing Products, 607 E. Market, Panora, IA 50216; (515) 755-2020.

Satellite City, P.O. Box 836, Simi Valley, CA 93062; (805) 583-0994.

Scale Model Technologies, 14783 S.W. 109th Ave., Ste. 7, Portland, OR 97224; (503) 639-2276.

Sermos R/C Snap Connectors Inc., Cedar Corners Station, Box 16787, Stamford, CT 06905; (203) 322-6294.

Slegers International, Rt 15, Wharton, NJ 07885; (201) 366-2525; fax (201) 366-0549.

SR Batteries Inc., Box 287, Bellport, NY 11713; (516) 286-0079; fax (516) 286-0901.

Sure Flite, 571 Crane St. Bldg. H, Lake Elsinore, CA 92530; (909) 245-6343.

SWB Turbines, 2418 Industrial Dr., Unit F, Neenah, WI 54956; (414) 725-3721; fax (414) 725-3721.

Testors, 620 Buckbee St., Rockford, IL 61104; (815) 962-6654; fax (815) 962-7401.

Thunder Tiger, 2430 Lacy Lane #120, Carrollton, TX 75006; (214) 243-8238; fax (214) 243-8255.

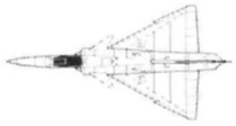
Ultimatesport Inc., P.O. Box 727, Soda Springs, ID 83276; (208) 547-3742; fax (208) 547-3700.

Vortac Mfg. Co., P.O. Box 469, Oak Lawn, IL 60453.

Webra; distributed by Horizon Hobby Distributors, 4105 Fieldstone Rd., Champaign, IL 61821; (217) 355-9511.

Yellow Aircraft, 203 Massachusetts Ave., Lexington, MA 02173; (617) 674-2222; fax (617) 674-2188.

Z-Poxy; distributed by Pacer Technology, 9420 Santa Anita Ave., Rancho Cucamonga, CA 91730.



INDEX OF MANUFACTURERS

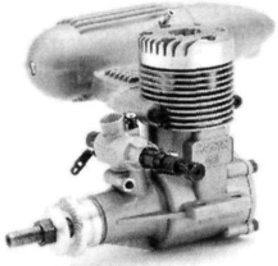
PRODUCT NEWS

VINCE MILLER DESIGNS
Piper PA-12 Super Cruiser

This ¼-scale Piper PA-12 Super Cruiser has a 107-inch wingspan. It can be built from accurate, scale plans; it's also available as a partially built kit and a completely built kit (fabric-covered, custom-painted with a detailed cockpit) that's ready for radio and engine installation.

Prices—$29.95—two sheets of plans; $40—heavy-duty fiberglass cowls; $150—partial kit; $1,200—built. (Prices do not include shipping and handling.)

Carl V. Miller, 3058 Copper Creek Road S.E., Rio Rancho, NM 87124; (505) 891-1298.



GLOBAL HOBBY DISTRIBUTORS
Magnum GPA .40 and .46 Engines

These new engines feature true chrome-plated ABC cylinders for more power and longer life, bronze Oilite bearings to reduce friction, and they're virtually maintenance-free. The dependability and fuel efficiency of GPA front-rotor Schnuerle porting will appeal to the sport flier. An automatic fuel-metered carburetor with dual needle valves will appeal to beginner and expert alike.

Prices—$102.95 (GPA .40—no. 210838), $112.95 (GPA .46—no. 210848).

Global Hobby Distributors, 10725 Ellis Ave., Fountain Valley, CA 92728-8610; (714) 963-0133; fax (714) 962-6452.

WINDSOR PROPELLER COMPANY
Scimitar Profile Propellers

Three new sizes in the Scimitar Profile Series have been released: 8x4, 9x7 and 10x8. These props have the efficient Scimitar shape with sweptback narrow tips and under-cambered blades. This design delivers greater thrust at low rpm. These competition props are available in 15 sizes in charcoal-gray, glass-filled nylon. Additional sizes will be released throughout 1995. For a free catalogue, send an SASE to Windsor Propeller.

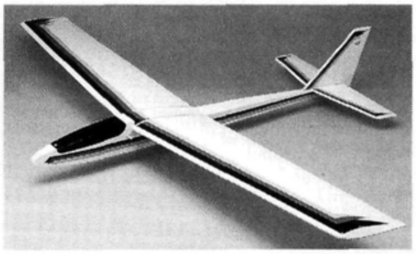
Windsor Propeller Co., 3219 Monier Cir., Rancho Cordova, CA 95742; (916) 631-8385; fax (916) 631-8386.

AEROTELEMETRY™
Mil-Std™ Series 300R Telemetry System

This integrated system accurately measures and telemeters engine rpm, indicated air speed and battery voltage up to 1 mile. It features a microprocessor-based digital transmitter and integrated sensor module. The hand-held receiver is portable, and data is displayed on the LCD in real time. The system comes preset from the factory for easy operation, and it includes a detailed instruction manual. Upgraded systems for 5 and 8 channels are also available.

Price—$1,195.

AeroTelemetry, 947 W. 30th St., Unit 24, Los Angeles, CA 90007; (800) 746-9380.



HOUSE OF BALSA
Over the Edge (O.T.E.)

This slope soarer—the latest addition to House of Balsa's kit line—uses traditional balsa and plywood construction. The kit includes Du-Bro hardware, full-size rolled plans, photo-illustrated instructions and 1 ounce of Zap-a-Gap. Specifications: wing loading—9 ounces per square foot; wingspan—62 inches; wing area—480 square inches; length—40 inches; weight—30 ounces; radio required—2-channel.

Price—$49.95.

House of Balsa, 10101 Yucca Rd., Adelanto, CA 92301; (619) 246-6462; fax (619) 246-8769.

J&J HOBBIES
Pilot Figurines

Each of these pilots is custom-made in the USA. Have one made to your specifications, and choose hair color, clothing, head position and eye color. (The eyes aren't painted on; miniature doll eyes are used.) Busts come with or without arms. These pilots are very light; a ⅓-scale, full-bodied pilot dressed in leather weighs approximately 12 ounces. Civilian, WW I, WW II, male or female pilots are available in ⅓, ¼, ⅕ and ⅙ scale, and they're ready to man the cockpit upon arrival.

Price—$34.95 and up.

J&J Hobbies, 313 Sandra Dr., Winchester, KY 40391; (606) 745-0449.

CLASSIFIEDS

RATES: non-commercial—25 cents per word (no commercial ads of any kind accepted at this rate); commercial— 50 cents per word (applies to retailers, manufacturers, etc.); count all initials, numbers, name and address, city, state, zip code and phone number. **All ads must be paid for in advance.** To run your ad for more than one month, multiply your payment by the number of months you want it to run. Deadline: the 10th day of the month, 3 months in advance, e.g., *January 10 for the April issue.* We don't furnish box numbers, and it isn't our policy to send tear sheets. **SEND AD AND PAYMENT TO: Elise Silkowski, CLASSIFIED ADS, Model Airplane News, 251 Danbury Rd., Wilton, CT 06897-3035, or call (203) 834-2339.**

R/C WORLD ORLANDO, FL, CONDO RENTAL: 2 bedroom, furnished. Available weekly or monthly. Low rates. 100-acre flying field with enclosed hangars. Close to Disney World and Epcot Center. For information, please call or write to R/C World, 1302 Stearman Ct., Orlando, FL 32825; (407) 380-6359.

ENGINES: IGNITION, GLOW, DIESEL—new, used, collectors, runners. Sell, trade, buy. Send $3 for huge list to Rob Eierman, 504 Las Posas, Ridgecrest, CA 93555; (619) 375-5537 [11/95]

MODEL MOTORS WANTED—Most types, 1970 and earlier. Cash or trade. T. Crouss, 100 Smyrna, West Springfield, MA 01089 [9/95]

FLY DAVE BROWN SIMULATOR. Use your transmitter. Works with Futaba, JR, Airtronics, Hitec. Uses Standard joystick connection. For more info, contact Computer Designs, 8530 N. Montana Ave., Helena, MT 59601;(406) 458-9416. [7/95]

ULTRALIGHT AIRCRAFT. One year old April '95, and our monthly publication is still growing. You can learn to fly the real thing. Buy, sell, trade, kit built, fixed wing, powered parachutes, rotor, sailplanes, trikes, balloons and more. Stories galore! Sample issue—$3. Annual subscription—$36. Introductory offer of only $24. (813) 539-0814."Ultraflight Magazine," 12545 70th St. N., Largo, Fl 34643-3025. [7/95]

ANTIQUE IGNITION-GLOW PARTS CATALOGUE, ½-inch thick, timers, needle valves, cylinder heads, pistons, points, tanks, spark plugs, racecar parts. Engines: ½As, Baby Cyclones, McCoys, Phantoms, etc. $8 postpaid (U.S.); $20 foreign, Chris Rossbach, R.D. 1, Queensboro Manor, Box 390, Gloversville, N.Y. 12078. [8/95]

SODA-CAN AIRPLANES—replica biplane detail plans with photos $7.50 PPD, Early's Craft, 15069 Valley Blvd. SP 26, Fontana, CA 92335. [8/95]

CARS. Selling model collection, 1973 issues up, 1/24-1/25, individual prices, about 800. Ralph, Box 2423-P, Yakima, WA; (509) 965-0670 [11/95]

WANTED: Model engines and racecars before 1950. Don Blackburn, P.O. Box 15143, Amarillo, TX 79105; (806) 622-1657. [10/95]

MAGAZINE BACK ISSUES—*American Modeler, American Aircraft Modeler, Aeromodeller, Model Airplane News, Model Aircraft, RCM* and more; 1930s–1990s. For list, send SASE to Carolyn Gierke, 1276 Ransom Rd., Lancaster, NY 14086. [9/95]

WANTED: ignition model engines 1930s to 1950s, especially Elf, Baby Cyclone, Brown Jr., Ohlsson Custom and Gold Seal. Also model racecars, any parts, spark plugs, etc; Woody Bartelt, 1301 W. Lafayette St., Sturgis, MI 49091; (616) 665-9693, or (800) 982-5464. [10/95]

PLANS TO BUILD more than 700 tools, machines and accessories for your shop. Catalogue–$1. Wood-Met. Dept. MAN, 3314 W. Shoff Cir. Peoria, IL 61604-5964. [9/95]

CASH FOR ENGINES: ignition, glow, diesel–all types; any condition; sale list, too! Estates my specialty! Send SASE for list. Bob Boumstein, 10970 Marcy Plaza, Omaha, NE 68154; (402) 334-0122. [11/95]

R/C SKYDIVNG-It's fun. It's different. It's a gravity-powered adventure! New, lower prices, new parachutes, *free* jump plane plans, etc., etc. Latest catalogue $1.00. R/C Skydivers, Box 662B, St. Croix Falls, WI 54024. [12/95]

INTERNATIONAL AIRCRAFT RESEARCH. Need documentation? Include name of aircraft (for availability of documentation) and $3 for three-view and photo catalogue. 1447 Helm Ct., Mississauga, Ontario, Canada L5J 3G3. [7/95]

WANTED: Model engines and racecars before 1956. Don Blackburn, P.O. Box 15143, Amarillo, TX 79105; (806) 622-1657. [12/95]

REPLICA SWISS WATCHES—18KT goldplated! Lowest prices! Two-year warranty! Waterproof! SubmDivers, DaytChronos, others! Phone (404) 682-0609; Fax (404) 682-1710.

WANTED: Old, unbuilt, plastic model kits from '50s and '60s. Send list, price to Models, Box 863, Wyandette, MI 48192. [2/97]

MICROLITE DETHERMALIZER .7 gram. Send large SASE to Wheels and Wings, P.O. Box 762, Lafayette, CA 94549-0762. [9/95]

NEW ZEALAND AERO PRODUCTS—Scale plans: Pawnee Brave, Pawnee, Airtruk/Skyfarmer, Agwagon, Fletcher FU-24, Cessna Aerobat, DC-3/C-47, Typhoon, Hall's Springfield Bulldog, Fairchild PT-19/Fleet PT-26, Rearwin Sportster and more. Fiberglass parts, hardware paks, color photo paks available. Free documentation with plans. Catalogue/price list: $5 (U.S.); Visa/MC. 34 Ward Parade, Stirling Point, Bluff, New Zealand. Phone/24 hr. fax—0064-03-212-8192. [2/96]

ENGINES, KITS & ACCESSORIES: 35-year collection for sale. For listing send #10 SSAE to: Ed Hagerlin, Box 1980, Overton, NV 89040. [8/95]

SCALE AIRCRAFT DOCUMENTATION and Resource Guide. Larger, updated 1995 edition. World's largest commercial collection. Over 5,500 different color FOTO-PAAKS and 30,000 three-view line drawings. 168-page resource guide/catalogue $8.00; Canada—$9.00; foreign—$14.00. Bob Banka's Scale Model Research, 3114 Yukon Ave., Costa Mesa, CA 92626; (714) 979-8058. [8/95]

WANT TO BUY: Old Cox, Wen-Mac, etc. Dealer catalogues, brochures, or signs. Thanks. Dean Barham, 4032 Iowa St., San Diego, CA 92104; (619) 528-1680. [8/95]

AERO FX BY JO DESIGNS—exact-scale, computer-cut, high-performance vinyl graphics and paint masks. Lettering; nose art; insignia for scale; pattern, pylon and sport fliers; complete graphic sets available. Call or write for free sample and catalogue. JO Designs, Rt. 1, Box 225 AA, Stratford, OK 74872; (405) 759-3333; fax (405) 759-3340. [11/95]

1992 NATS VIDEO. Two-hour documentary includes R/C and C/L scale, C/L carrier, R/C helicopters, R/C pylon racing, C/L combat, Speed and aerobatics, free flight indoor and outdoor. Includes interviews with fliers and officials, Voice-overs and original music. $29 (S&H included), NY add 8.25% to: Alan Abriss Productions, 94-20 66th Ave., Forest Hills, NY 11374. [9/95]

BOB FIORENZE BUILDING SERVICE. Jets, warbirds and helicopters. Contact Bob at (407) 327-6353. Our experience is your best assurance. [12/95]

R/C FLIGHT TRAINING. Your training is fun and easy in far western North Carolina, near Murphy on your map. Write or call. R/C Flight Training, 120 Setawig Rd., Brasstown, NC 28902; (704) 389-8968. [9/95]

MODEL AIRPLANE NEWS, 1930-1980; "Air Trails," 1935-1952; "Young Men," 1952-1956; "American Modeler," 1957-1967; "American Aircraft Modeler," 1968-1975. $1 for list. George Reith, 3597 Arbutus Dr. N., Cobble Hill, B.C. Canada V0R 1L1. [8/95]

PROPELLER DYNAMICS: Qualitative Fundamentals, Sherlock. Non-mathematical introduction to theory of aircraft propellers. Chapters include historical perspective; selection of airfoils; vortex flow; efficiency; propeller performance curves and noise. 90 A4 pages, 10 photos, 18 diagrams, softcover. U.S. $25 air postpaid to anywhere on planet. Orders to S.L. Sherlock, 42 Hepburn Way, Balga 6061 WA, Australia, or phone/fax 61 9 2472481. Payment check in Australian dollars, Visa or Mastercard. [8/95]

FOR SALE: a model engine collection with 20 engines of all displacements. Write to: Udo E. Linke, Caixa Postal 24, 18130-000 - Sao Roque - S.P., Brazil. [7/95]

WANTED: Top Flite F8F2 Bearcat kits. Will Whiteside, 713 Trowbridge St., Santa Rosa, CA 95401; (707) 579-4818. [8/95]

WANTED: Midwest RK-049 fan unit, or any fan to fit 049 engine. Also wanted: Cox car kits pre-1980. B. Sperle, Box 1552, Unity Saskatchewan, Canada S0K 4L0; (306) 228-3629. [8/95]

QUADRA Q52. Like new, not broken in. Extras. $280. Kohler, 3640 Nautilus, Aurora, OH 44202. [7/95]

MODEL COLLECTOR—For sale, large collection of models (40's, 50's, 60's, U/C, R/C, F/F, solids); trades possible. Call or write (SASE) for list: Dr. Frank Iacobellis, 62 Palisane Rd., Rye, NY 10580; (914) 967-5550. [7/95]

FOR SALE—M.A.N. scratch DC-3 60% completed 94-inch wing. All structural material included $100 FOB. Richard Mooers, 901 Queen Annes Ct., Hagerstown, MD 21740; (301) 797-9554. [7/95]

R/C AERIAL PHOTOGRAPHY—From the makers of "R/C Airborne Videos," by Adrian and Hugh Kingsford—Plans of proven camera-carrying model aircraft. "PTERODACTYL" (Hand-launched), "LOFTUS" (Multi-role surveillance), PHOENIX MK II (14-foot span)! Send U.S. $5 for info to: 12 Toru St., Mapua, Nelson, New Zealand. ph.—(03) 540. 2577. [7/95]

GEE BEE PLANS (Delmar used). R-1, R-2, "Z." Seven more, ⅓, ¼, smaller. Airplane goodies! Catalogue/News $4, refundable. Vern Clements, 308 Palo Alto, Caldwell, ID 83605. (208) 459-7608. [7/95]

ANTIQUE IGNITION engine parts: excellent reproductions, fuel tanks, points, timers, coils, needle valves, gaskets, etc. Champion spark plugs. Catalogue—$5 (intl. airmail—$7). Aero-Electric, 1301 W. Lafayette St., Sturgis, MI 49091. [10/95]

HOMELITE 25cc: New, aircraft conversion includes: prop hub, muffler, choke, primer, mount, solid-state ignition, $175pp. Doug, P.O. Box 406, Broad Brook, CT 06016. All inquiries answered. [7/95]

FLAPERONS, ELEVONS, vee tails, wings, dual throttles, need the MicroMixer. Tiny ⅓ ounce. Airborne computer mixing for standard radios! Without connectors, $29 assembled, $21 kit, $2.25 shipping. Quillen Engineering, 561 N. 750 W., Hobart, IN 46342. [7/95]

GIANT-SCALE PLANS by Hostetler. Send SASE to Wendell Hostetler's Plans, 1041 B Heatherwood, Orrville, OH 44667. [12/95]

PLANS ENLARGING. Old model magazines, scanning, plotting, model software. Free information. Concept, P.O. Box 669A, Poway, CA 92074-0669; (619) 486-2464. [8/95]

WW I PLANS. Over 400 in stock. Peanut to 100 inches. Lazer-cut ribs available. Send three, $1 bills for illustrated catalogue to Clarke Smiley, 23 Riverbend Rd., Newmarket, NH 03857. [11/95]

SHIRTS, HATS, COFFEE MUGS, etc., with your favorite photo or club logo. Quantity discounts. Send SASE for info and prices to: P&F Hobbies, 12610 266th Ave. S.E., Monroe, WA 98272. [8/95]

R/C HOTLINE—Buy, sell, trade instantly. Planes, helicopters, boats, cars, 1-900-976-6335 (MODEL). This line is for the R/C modelers who are interested in listening to ads from around the country or placing their ad for others to hear. Call cost $2.99 min. Must be 18 to call. [8/95]

ANTIQUE MAGAZINES: Complete private collection. Bill Barnes Pulps, *Air Trails, Flying Aces,* others. $1 for list. Bruce Thompson, 328 St. Germain Ave., Toronto, Ontario, Canada M5M 1W3. [8/95]

WANTED: Thimble-Drone RR-1 also Monogram Speedy-Built kits, any condition considered. Contact Gary Meyers, 9107 E. Milton, Overland, MO 63114; (314) 429-7792. [8/95]

KITES: FREE COLOR CATALOGUE—(800) 724-7267, ext. K-MAN. Over 200 kites—from easy-to-fly to high-performance 60mph stunt kites! Get your 80-page, full-color catalogue today! [7/95]

FOR SALE—Mfg. selling out high-quality molds, tooling, parts, plans, rights, etc., for giant-scale fiberglass DC-3 kit. Kits sold around the world and also to be seen in the upcoming movie "CONGO." Will sell or trade, make offer. Call Columbia Model Works; (314) 474-3285 eves. [7/95]

FUTABA FP-7UAP Super 7 PCM 1024 radio control. Radio and battery only, no transmitter, receiver or accessories. New in box. No reasonable offer reused. Call Joe at (203) 661-6532. [8/95]

PLANS ACCURATELY ENLARGED or copied. Any scale, any size. Money-back guarantee. Send $2 for info and a customized poster for your shop. Roland Friestad, 2211M 155th St., Cameron, IL 61423. [12/95]

PAYING $75 each for following toy metal outboard boat motors: Gale Sovereign, Buccaneer, Johnson, Oliver, Mercury, Evinrude, Scott, Sea-Fury, Wen-Mac. Paying $300 each for Lionel locomotives # 773, 746. Also want Dinky toys, tin toys made in Japan. Richard Gronowski, 140 N. Garfield Ave., Traverse City, MI 49686; (616) 941-2111. [7/95]

OLD MODEL MAGAZINES. Five different at least 20 years old: $12. Five different at least 30 years old: $16. Issues of my choice. Walter Baird, 155 Greenbriar Dr., Tallmadge, OH 44278. [8/95]

SOARING VIDEO: 50 minutes of basic R/C glider technique taken from "Old Buzzard's Soaring Book." Video $27.95, book $16.95, both $39.95 postpaid. Dave Thornburg, 5 Monticello, Albuquerque, NM 87123; (505) 299-8749. [12/95]

HISTORIC REPLICAS: DISCOUNTS! Flying Tigers, 94th Aero, Lafayette Escadrille accessories, pilot sport shirts, T-shirts, wings, medals, beer steins, scarves, WW I squadron pins from $4.95. Free gift with order. Catalogue $1, refundable. Company of Eagles, 875A Island Dr., Ste. 322N, Alameda, CA 94502. [9/95]

VIDEOS: Top Gun '95, $24.95 plus S&H. Top Gun '94, R/C Know How, North Carolina Big Bird Fun Flys, Greenville NC Fun Fly. 2 hours. Send $19.95 plus $3 S&H to E&H Video, 134 Wildwood Dr., New Bern, NC 28562. NC residents add 6% tax. (919) 637-3416. [9/95]

WANTED: Ace Digipace II in like-new condition. Graham Thornton, 1303 Avenida De Cortez, Pacific Palisades, CA 90272. [7/95]

SCALE PLANS AND PHOTO SERVICE: Four scale catalogues; SPPS 163 Superscale Plans, SPPS Documentation Photos, 3-views, Argus Scale Plans Handbook, Argus 3-view Scale Drawings. The Best! $5 each USA and Canada. $10 each overseas Air. SASE for enlarging prices. Jim Pepino's Scale Plans and Photo Service, 3209 Madison Ave., Greensboro, NC 27403; phone/fax (910) 292-5239. Visa, Mastercard. [12/95]

CUSTOM T-SHIRTS. Have your favorite photo of you and your R/C plane put on a white T-shirt with whatever saying you want. Up to 2 lines. Just send photo along with check or money order. $15.95 + $4 S&H L, XL, XXL; $16.95 + $4 S&H XXXL. Please state size when ordering. To: Jim's Custom T's, 1203 Mukwonago Dr., Mukwonago, WI 53149. WI residents add 5% sales tax. For more info, call (414) 363-2185. Photo will be returned. [7/95]

FLYING ACES CLUB VIDEOS: 1993 and 1994 national competition from Geneseo, NY, each tape featuring two hours of stick and tissue free flight models, $22.50 each or both for $39 post paid to: Charlie Sauter, 3372 Kirkham Rd., Columbus, OH 43221. [7/95]

FOR SALE: Older 6-channel MRC radio series 7662, 3 servos, 72.400MHz, needs batteries. $40 + postage. Hemostats: S.S., 5 inch, 2/$6 or 4/$10 + postage. Wanted: Frequency monitor or spectrum analyzer. Don Springer, 99 Lerma Court, Kissimmee, FL 34743. [9/95]

GLENNIS AIRCRAFT—Now offering over 460 different sizes and styles of wheels and tires for whatever model aircraft you are flying, building or dreaming about. New lighter weight tires. We are also coming out with some new products for '95. Call (916) 742-3957 for more info, or send $5 to Glennis Aircraft, 5528 Arboga Rd, Linda, CA 95901 for 1995 catalogue. [7/95]

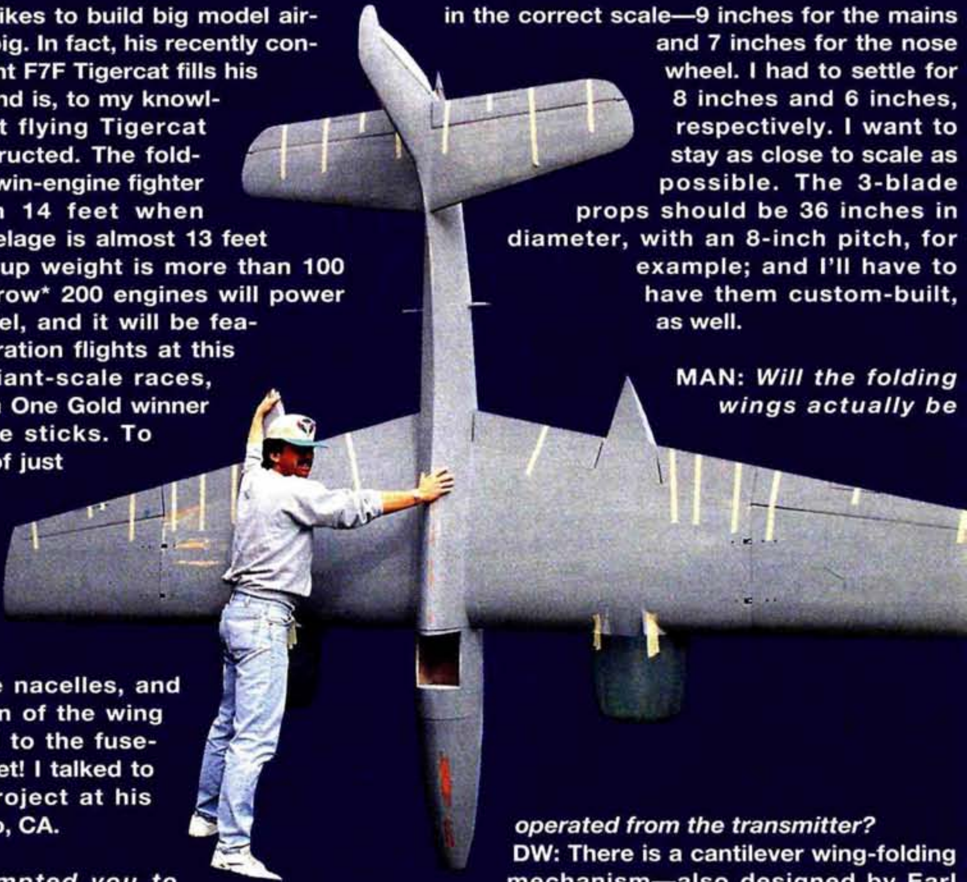
HELICOPTER SCHOOL. Five days of hands-on instructions with X-Cell helicopters and Futaba and JR computer radios. Small classes, tailored to your individual needs, beginners to expert. Includes all meals and lodging. Over 420 students from 23 countries and 44 states, logging 14,500 flights in the last five years. Located on a 67-acre airport used exclusively for R/C training. Owned and operated by Ernie Huber, five-time National Helicopter Champion. Send for free information and class schedule now! P.O. Box 727, Crescent City, FL 32112; phone (800) 452-1677; fax (904) 698-4724. Outside U.S., phone (904) 698-4275. [12/95]

LIFETIME COLLECTION of over 600 model airplane and a few car kits of all types. $4,000 firm. For more information, call or write: David Wilson, P.O. Box 189, Reynoldsburg, OH 43068; (614) 491-3718. [9/95]

FINAL APPROACH

THE BIGGEST TIGERCAT

DAN WILLIAMS likes to build big model airplanes. *Really* big. In fact, his recently constructed 29-percent F7F Tigercat fills his two-car garage, and is, to my knowledge, the largest flying Tigercat model ever constructed. The folding wings of this twin-engine fighter span more than 14 feet when extended, the fuselage is almost 13 feet long, and the all-up weight is more than 100 pounds. Two Aerrow* 200 engines will power the monster model, and it will be featured in demonstration flights at this year's Madera giant-scale races, with 1994 Formula One Gold winner Bryan Keil on the sticks. To give you an idea of just how big it is, imagine this: the fuselage of Byron*'s new 1/4-scale Gee Bee will fit inside one of the Tigercat's engine nacelles, and the center section of the wing (which is integral to the fuselage) spans 8½ feet! I talked to Dan about his project at his home in San Bruno, CA.



MAN: *What prompted you to build this huge Tigercat?*
DW: Well, I'm always looking for something unique, something you don't see every day. There are only a few F7F Tigercat models flying right now—but none in this size. Also, unlike the typical Tigercat, the full-scale version of this design had carrier-type folding wings, but it was never actually entered into service. This model will be the first Tigercat in any scale of this configuration to be built from the original factory drawings.

MAN: *Are you saying you scratch-built this model from full-scale drawings?*
DW: No, but Dan Palmer designed a smaller kit from the factory drawings, and I had the plans blown up to 29-percent scale.

PHOTOS BY ROB WOOD

MAN: *Tell me about some of the engineering challenges you faced in this project.*
DW: Well, the retracts had to be custom-built. I'm using Likes Line* boxes, but I had the gear legs built by Earl Aune of Scale Model Technologies*. The front gear has a servo built into it for steering.

Another problem I've had is in finding wheels in the correct scale—9 inches for the mains and 7 inches for the nose wheel. I had to settle for 8 inches and 6 inches, respectively. I want to stay as close to scale as possible. The 3-blade props should be 36 inches in diameter, with an 8-inch pitch, for example; and I'll have to have them custom-built, as well.

MAN: *Will the folding wings actually be operated from the transmitter?*
DW: There is a cantilever wing-folding mechanism—also designed by Earl Aune—that is available for this aircraft, although it will have to be scaled up.

MAN: *Tell me about the construction materials you used.*
DW: The aircraft is built mostly of balsa, with hardwood spars and balsa skins over Lauan lite-ply ribs. The 16-inch-diameter cowls are fiberglass.

MAN: *Well, it's big and it's beautiful, but will it fly?*
DW: The plane should glide quite well; it has a lot of dihedral, and the full-scale version was a very stable aircraft (very *fast* aircraft, to be exact). The Tigercat models that have been built in smaller scales have been very successful.

The Tigercat will be painted in the distinctive orange and white scheme featured on the only full-scale Tigercat to qualify for the Reno National Air Races (race no. 62; entered and flown by Robert Forbes in 1976). Mr. Forbes is expected to be on hand for the Madera demonstration flights and will be available for questions about the aircraft.

Look for the Tigercat in Madera at the Classical Racing pit, and don't miss the flights. Those two 12ci engines should make for an awesome show! —*Rob Wood*

**Addresses are listed alphabetically in the Index of Manufacturers on page 130.*